

FITNESS NUTRITION

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SUBJECTS
COVERED

FITNESS NUTRITION

Food Selection

Animal Cells, Human Organ Systems, and the Digestive System

Macro and Micronutrients

Vitamins, Minerals, and Hydration

Behavior Modification Stages and Strategies

Client Assessments

Setting Effective Goals

Nutrition Coaching Business

Supplementation

Product Labels and Claims

Dietary Guidelines and Trends

Nutrition for Special Populations

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NUTRITION

LEARNING OBJECTIVES

- 1 | Describe how humans select foods.
- 2 | Explain the types of functional foods.
- 3 | Understand the cultural, economic, and religious considerations of some diets.

In 400 BC, the Greek physician Hippocrates declared, “Let thy food be thy medicine and thy medicine be thy food.” The ancient “father of medicine” had begun to realize a person’s health is greatly impacted by their food, and it could be used to prevent disease and maintain wellness.

Over time, simple observations have led to many scientific discoveries and declarations regarding nutrition, nutrients, and how the body turns food on a plate into energy for life. In 1747, Dr. James Lind of the British Navy discovered scurvy in sailors who were only fed bread and meat. His experiments with items such as salt water, citrus fruit, and vinegar allowed him to find evidence that citrus prevented the disease even though vitamin C wasn’t discovered until 1912 and not chemically produced until the 1930s.

Figure 1.1 Dutch Sailors Died of Scurvy Illustrated in the Le Tour de Monde Travel Journal (1865)



In the 1770s, Antoine Lavoisier used his knowledge of chemistry to develop the concept of the body’s metabolism without knowledge of elements such as carbon, nitrogen, and hydrogen, which weren’t discovered until the 1800s. Vitamins and their importance in health and wellness were discovered in the early 1900s by European doctors.

The research and scientific discoveries in the field of dietetics and nutrition continue to this day. With the introduction of the nutrition field in the late 19th century, nutrition experts have been employed in hospitals to monitor troops, schools to ensure balanced meals for youth, and as a major aspect of the fitness and general health industries.

Pursuing the education needed to successfully coach clients for health and fitness goals and improve overall well-being requires attention to detail and discussion of many topics. As awareness of how nutrition affects the health of each individual grows, the economic and demographic status, life stage, and energy requirements must all be considered. Topics like human energy systems, the digestive system, metabolism, and the human cell are critical for a nutrition coach to understand.

HOW HUMANS SELECT FOOD

The appeal of food goes beyond the need for energy and nutrients. Humans select food based on their senses: sight, smell, taste, and feel.

SIGHT

The eyes provide the first impression of food, such as the shape, color, shine, texture, size, and presence of defects. A human can discern information from what they see, like how ripe a fruit is or if it has been heated or burned. The color of foods contributes to their appeal to the consumer as well.

SMELL

The human **olfactory system** can discern between 2,000 and 4,000 different smells, with highly sensitive people being able to distinguish up to 10,000 different odors. The nose detects the **volatile molecules** of foods, which are generated from the application of heat. Therefore, it is far easier to smell warm foods than cold ones.

TASTE

When consuming food, **taste** is typically the most influential sense. The taste buds in the mouth are arranged on the tongue but are also found in the palate and in the pharynx. The addition of saliva to food makes it possible to taste, and this sense is a combination of smell and taste (volatile and nonvolatile compounds). Every human has between 9,000 and 10,000 taste buds, but they diminish over time. As humans age, they can still taste just fine but may find themselves using far more seasonings on their foods.

Through taste, humans can discern bitter, sour, sweet, salty, and **umami** (savory).

OLFACTORY SYSTEM:

The organ system used for smelling.

VOLATILE MOLECULES:

Small, vaporized particles.

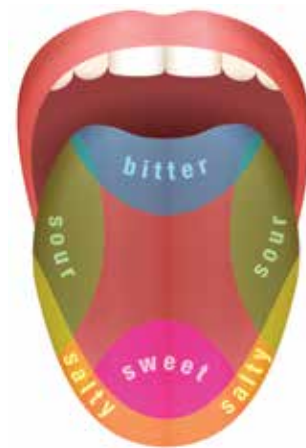
TASTE:

The perception stimulated when a substance in the mouth reacts chemically with a taste receptor cell in the oral cavity.

UMAMI:

One of the five categories of taste in food, corresponding to the flavor of glutamates, especially monosodium glutamate.

Figure 1.2 Map of the Human Tongue



FEEL

MOUTHFEEL:

The physical sensations in the mouth caused by food or drink.

PALATABLE:

Pleasant to taste.

CONSISTENCY:

The firmness or thickness of a food.

FLAVOR:

A combination of taste, smell, and mouthfeel.

Texture (how foods feel to the hands as people handle them) and **mouthfeel** as they consume it drive the way humans select foods. While this sensation is unique for everyone, texture can affect the way the brain processes the taste and smell of a food. For example, if someone does not like the texture of a tomato, it may taste “bad” to them. However, the texture of tomato paste (which is simply pureed tomato) may not bother them, and this taste is **palatable**. The **consistency** of food describes its firmness or thickness and goes hand in hand with food texture.

FLAVOR

Flavor is not a sensory tool used by humans but a combination of taste, smell, and mouthfeel. This explains why a stuffy nose makes food taste very different than when the sinuses are clear. Flavor is a very important factor determining the success or failure of food items (processed and fresh) in the consumer marketplace. Flavor is heavily influenced by the amount of fat in the food. This explains why reduced fat or fat-free products do not taste quite the same as their full fat counterparts. However, the addition of other compounds like sugar or sweeteners to lower fat foods may make them taste sweeter.

FUNCTIONAL FOODS

FUNCTIONAL FOODS:

Foods selected, produced, or consumed for reasons beyond calorie and nutrient content.

Foods for a specified health use are referred to as **functional foods**. Functional foods are those selected, produced, or consumed for reasons beyond calorie and nutrient content. This term was coined in Japan, where the functional food market is one of the most advanced in the world. Functional foods are divided into four categories: modified foods, conventional foods, medical foods, and special dietary foods.

MODIFIED FOODS

Modified foods are foods modified through enhancement, enrichment, or nutrient fortification. This can include calcium-fortified juice, folate-enriched breads, and beverages enhanced with energy-promoting substances like caffeine and vitamin B complex.

MODIFIED FOODS:

Foods modified through enhancement, enrichment, or nutrient fortification.

CONVENTIONAL FOODS

Conventional foods are simple, unmodified whole foods like vegetables and fruits. These foods have been linked to reduced cancer and chronic disease risk, heart health, and urinary tract function. Examples include broccoli, tomatoes, and kale.

CONVENTIONAL FOODS:

Simple, unmodified whole foods like vegetables and fruits.

MEDICAL FOODS

Medical foods are defined as foods intended to be ingested under the supervision of a physician for specific dietary management of a disease or condition. Examples include canned or bottled supplements for the treatment of diabetes or liver disease.

MEDICAL FOODS:

Food intended to be ingested under the supervision of a physician for specific dietary management of a disease or condition.

SPECIALTY DIETARY FOODS

Specialty dietary foods are defined by the Federal Food, Drug, and Cosmetic Act with three distinctions:

- 1 They support a dietary need from a physiological, physical, or pathological condition.
- 2 They supply vitamins, minerals, or other ingredients with the intent of increasing intake.
- 3 They support a dietary need by being a sole item in a diet (lactose free, gluten free, or similar).

SPECIALTY DIETARY FOODS:

Foods supporting a condition, supplying vitamins or minerals to increase intake, or serving as the sole item in a diet.

CULTURE, ECONOMICS, AND RELIGION

There are several factors affecting a person's access to food, food selections, and the way they consume foods. These include cultural, economic, and religious considerations.

CULTURAL CONSIDERATIONS

Culture describes the ideas, customs, skills, and art of a group of people in a period of civilization. Many cultures exist, including American culture. The Papuan people of Papua New Guinea, the Gauchos of South America, and the San people of Botswana are also examples of the many cultures around the world. In some cultures, food is prized, and in others, it is spurned. Whale blubber is a staple in arctic areas, and dog is considered a delicacy in parts of Asia. Grubs are consumed for protein in Australia, escargot (snails) are popular in France, and sushi is an Asian staple becoming more popular across the globe.

CULTURE:

The ideas, customs, skills, and art of a group of people in a period of civilization.

Figure 1.3 San Bushmen of Mariental, Namibia



Ethnicity and Place of Birth

The ethnic origins of an individual and their place of birth will determine what foods they are exposed to. Nearly 25 percent of the American population are ethnic minorities or were born in another country before coming to the United States. The foods that are commonplace or influenced by their cultures have traveled to the United States with them, and foods like pizza, Thai, Moroccan, and Vietnamese cuisine are more common.

Figure 1.4 Ethnic foods can be found in most cities.



ECONOMIC CONSIDERATIONS

The availability of food can change based on the local economic status of a city or neighborhood. Many Americans live in **food deserts**—urban areas where fresh fruits, vegetables, and meats are not readily available. In these areas, consumers rely on processed foods from convenience stores and markets.

FOOD DESERTS:

Urban areas where it is difficult to afford or find quality whole foods.

Figure 1.5 Markets Are Common, but Not Everywhere



When fresh, whole foods are available, they may be financially out of reach. The cost of fresh fruits is generally higher than the cost of processed, sugary foods, and families and individuals with income restrictions will often forgo the healthy options for the less expensive, unhealthy ones. Government assistance programs are becoming more widely available to reduce the cost of whole foods and supply extra funds dedicated to groceries for individuals and families in need.

RELIGIOUS CONSIDERATIONS

The religions of the world have also made their way to America and have spread to nearly every continent. The selection of foods and the way they are prepared can vary between religious groups. For example, Buddhists consider it uncompassionate to eat the flesh of another living creature, and many, though not all, are vegetarians. Hindus do not believe in injuring or killing an animal for its meat. Cows are sacred in that culture. Thus, the devout Hindu diet rejects poultry, eggs, and meats.

Figure 1.6 A Jewish Holiday Meal



KOSHER:

Foods “fit” for consumption per the requirements of Jewish law.

HALAL FOODS:

Foods deemed “acceptable” for consumption by Muslim law.

The Mormon church discourages parishioners from drinking coffee, alcohol, and tea. In the Orthodox Jewish faith, the consumption of **kosher** foods. Kosher foods include ruminant animals (sheep, cows, and goats), chicken, goose, fruits, and vegetables. The allowed animals are considered kosher if their slaughter is supervised by a rabbi or authorized individual to ensure the blood is removed properly. Similarly, **halal foods** are permitted foods in Islam. Halal foods do not allow animal blood, improper slaughter, intoxicants, or decay.

Holidays for religious groups like Passover, Ramadan, or Lent can affect the foods consumed or the frequency and timing of food consumption. Many religious holidays involve fasting or food restrictions during a set period.





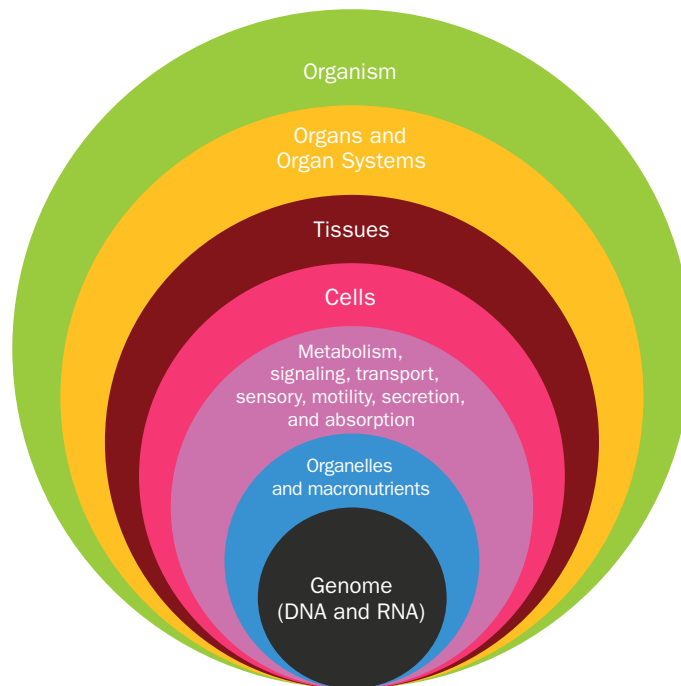
CELLS, ORGAN SYSTEMS, AND DIGESTION

LEARNING OBJECTIVES

- 1 | Understand the structure and function of the animal cell.
- 2 | Differentiate between the various types of cells in the body.
- 3 | Understand the human organ systems and their interconnected nature.
- 4 | Describe the aspects of the human digestive system and their functions.

The human cell is the basic building block, and trillions of these cells are found in each living person. The cells provide structure, absorb nutrients, generate energy, move waste, and perform specialized functions essential to life. Depending on the location of a cell, the function and makeup will vary.

In the hierarchy of the human body, cells accommodate energy metabolism, cell signaling, genetic growth and replication, and transport in addition to other functions. Proteins, genetic material, and the macronutrients protein, fat, and carbohydrates exist within cells. Masses of cells make up tissues, organs, organ systems, and the organism that is the human.



CELL COMPOSITION

MACRONUTRIENTS:

A type of food required in large amounts in the diet.

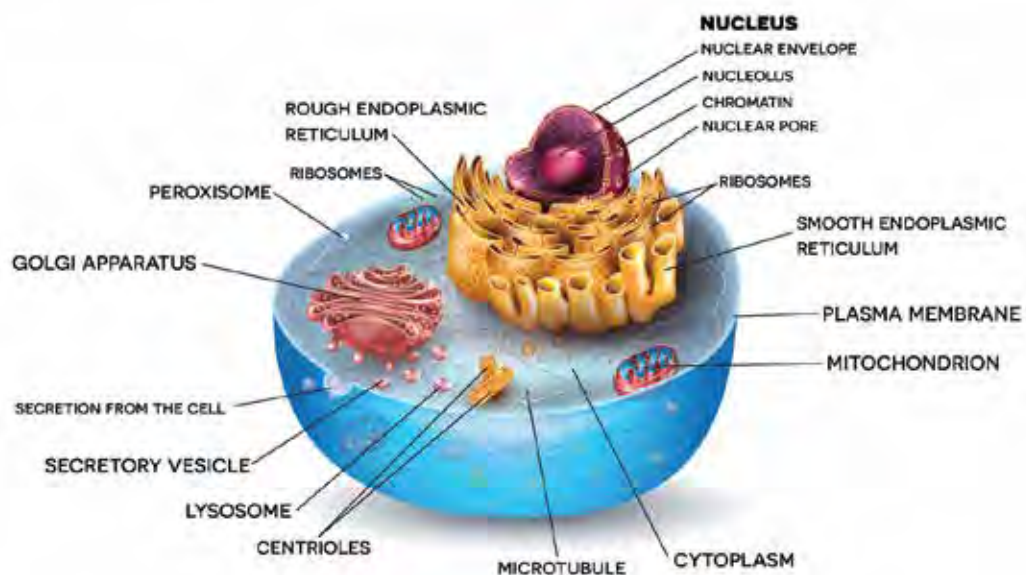
ORGANELLES:

Structures in a living cell performing specialized metabolic tasks.

Cells are made up of water and both organic and inorganic molecules, with water making up about 70 percent of a cell's mass. All three **macronutrients**—fat, carbohydrate, and protein—are present in cells.

The basic animal cell is made up of a cell wall, cytoplasm, and a nucleus. Within the cytoplasm are **organelles**, structures in a living cell performing specialized metabolic tasks. The organelles manage processes ranging from the replication of genetic material to excretion of waste and energy production.

Figure 2.1 The Anatomy of an Animal Cell.



Many of the organelles interact during cellular processes, but each has a distinct function.

Table 2.1 The Organelles of a Human Cell.

ORGANELLE	FUNCTION
Nucleolus	Generates ribosomes and cell-signaling particles
Nucleus	Holds the cell's genetic material
Ribosome	Performs biological protein synthesis
Vesicle	Performs secretion from a cell, uptake into a cell, and material transport within a cell
Rough endoplasmic reticulum	Produces proteins
Smooth endoplasmic reticulum	Produces lipids and steroid hormones, stores calcium ions, and removes metabolic by-products
Golgi apparatus	Packages proteins into vesicles for transport
Centriole	Aids in cell division
Mitochondria	Generate cellular energy
Lysosome	Digests and removes waste within the cell
Peroxisome	Produces water and breaks down fatty acids
Microtubule	Provides structure and shape to the cell

CELL MEMBRANE:

The lipid bilayer enclosing human cells.

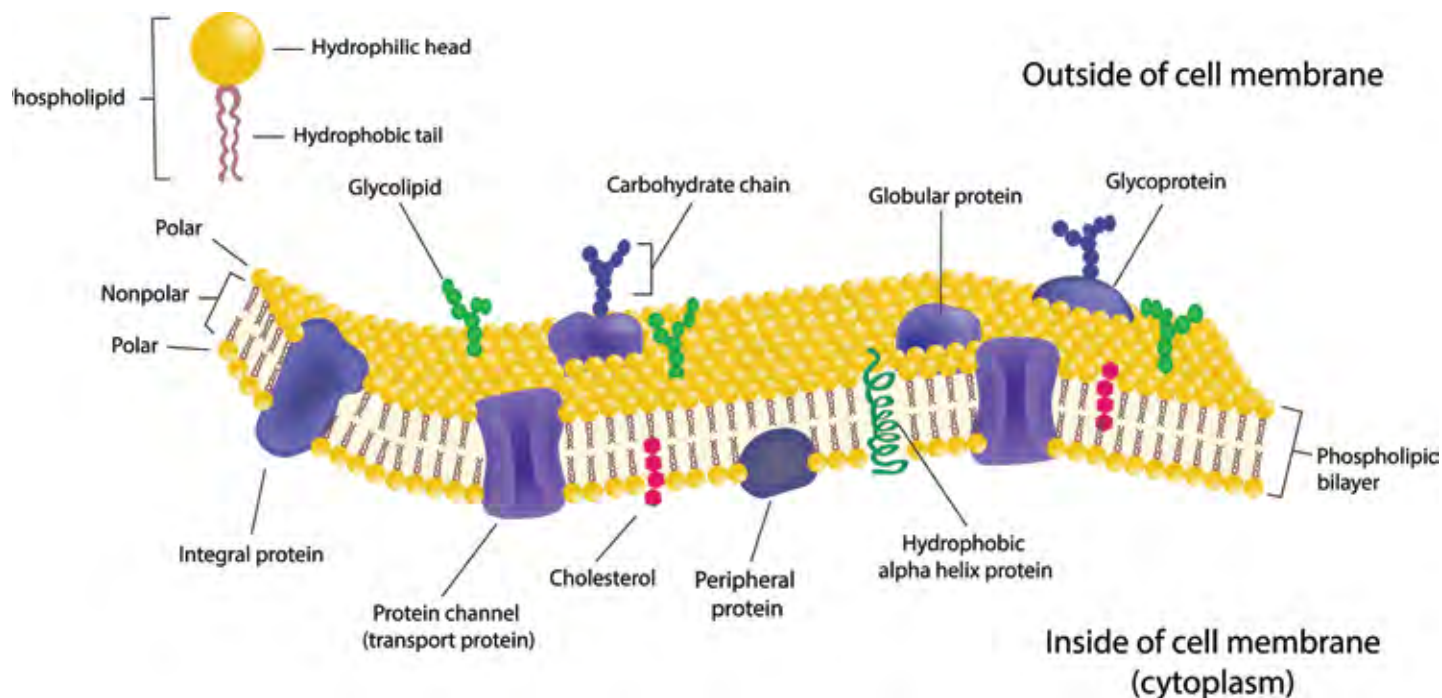
LIPID BILAYER:

A thin polar membrane made of pairs of lipid molecules.

STRUCTURAL COMPOSITION

The external structure of the **cell membrane** is important for life, as it serves to protect each cell but also allows them to interact with one another. This membrane encloses each cell and is embedded with proteins allowing molecules to cross the **lipid bilayer**

Figure 2.2 The Cell Membrane (Lipid Bilayer).



PHOSPHOLIPIDS:

A fatty acid linked through glycerol phosphate forming cell membranes.

HYDROPHILIC:

Water-loving; attracted to water.

HYDROPHOBIC:

Water hating; repelled by water.

Proteins can be embedded in the lipid bilayer or serve as transport proteins through the bilayer. Glycoproteins attach to the extracellular proteins and carbohydrate molecules, while glycolipids attach directly to the bilayer. Cholesterol can also be embedded in the bilayer, while some helix proteins can span the bilayer.

Proteins make up about 60 percent of a cell membrane with the other 40 percent composed of fats. The fats making up the lipid bilayer are called **phospholipids** and are made of polar **hydrophilic** heads and two chains for a **hydrophobic** tail. The hydrophobic tails are repelled by the aqueous (water-filled) environment within and outside the cell and form the lipid bilayer structure.

HUMAN CELL TYPES

The human body is composed of many different cell types, each with a specific function. Technically, there are more than 200 different types of cells present in an adult human. Some of these cells have functions that do not require the standard organelles and may result in varied physical appearance to suit their functions.

Shortly after the fertilization of a human egg by a sperm cell, a bundle of 70–100 cells called a **blastocyst** is formed. The blastocyst forms about five days after a sperm cell fertilizes an ovum and is full of mostly undifferentiated cells that can become any of the cell types within the body as they continue to divide and grow. Each human **tissue** has specific functions and, thus, specific cells to perform the functions.

BLASTOCYST:

A bundle of 70–100 mostly undifferentiated human cells.

TISSUE:

Groups of cells having similar structure and acting together to perform a function.

Figure 2.3 Stem Cell.

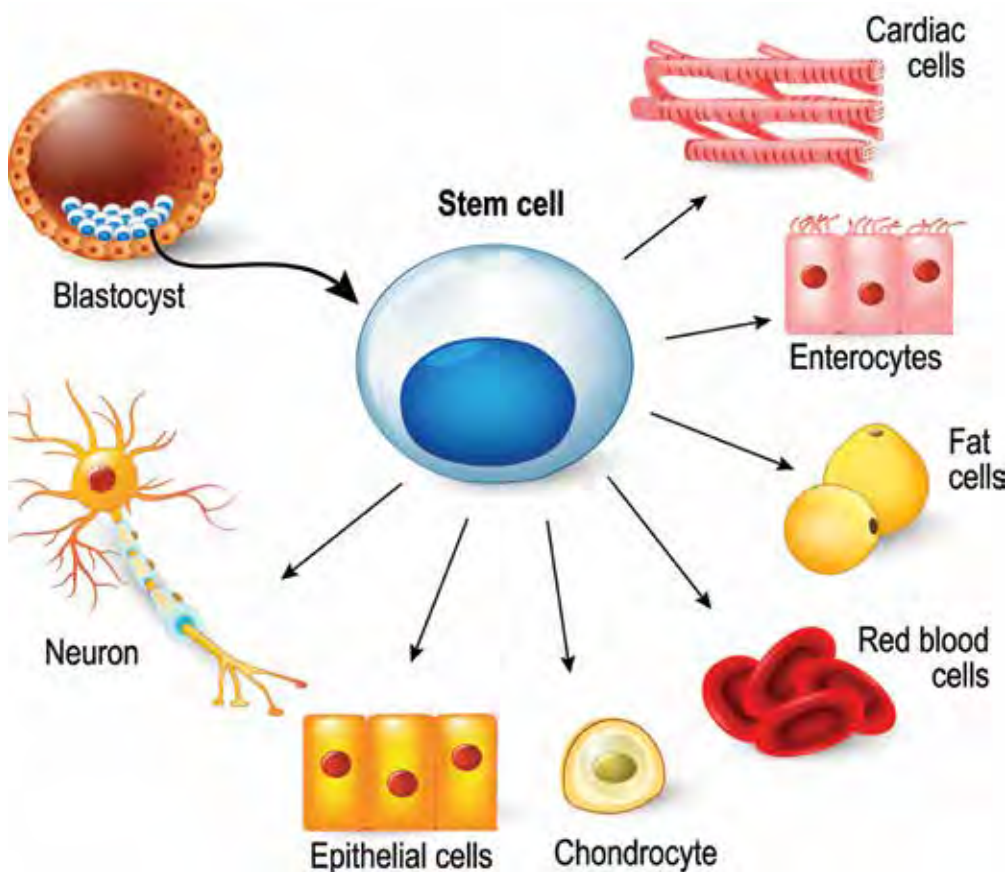


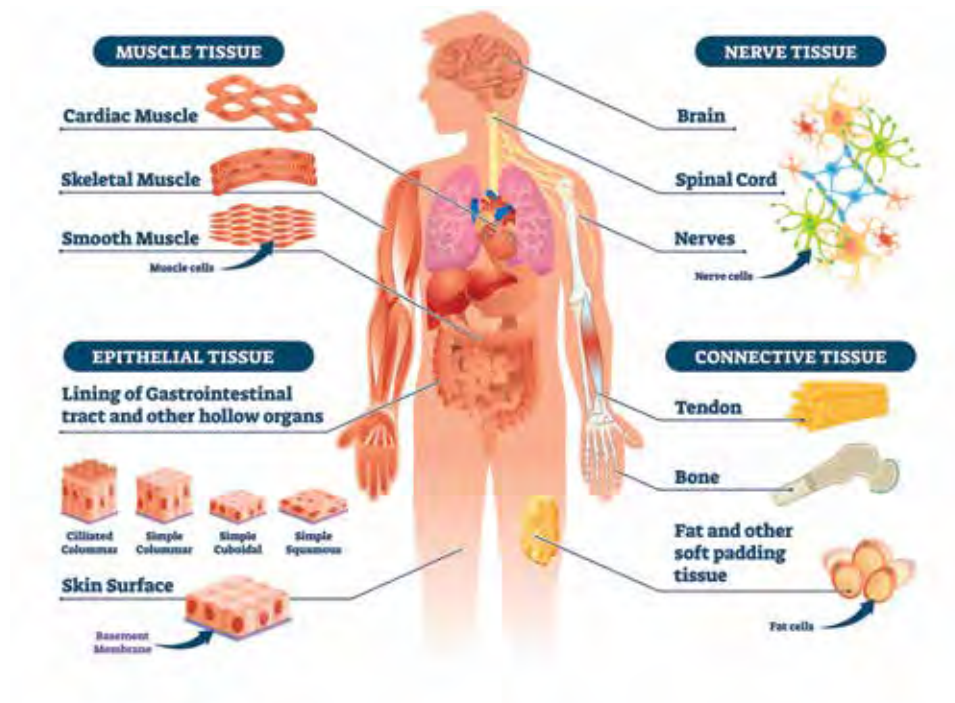
Table 2.2 Prevalent Human Cell Types.

CATEGORY	EXAMPLE(S)/LOCATION	FUNCTION(S)
Stem cell	Blastocyst	Undifferentiated cells
Red blood cell	Erythrocyte	Transports oxygen
White blood cell	Lymphocyte, basophil, neutrophil	Immunity and pathogen response
Platelet	Megakaryocytes	Blood clotting
Nerve cell	Neuron	Transmits nerve impulses
Neuroglial cell	Glial cell	Modulates rates of nerve signal propagation in the brain and repair of neural injury
Muscle cell	Myocyte, skeletal, cardiac, smooth	Muscular contraction, voluntary and involuntary
Cartilage cell	Chondrocyte	Physical support and shock absorption
Bone cell	Osteoclast, osteoblast, osteocyte, lining cell	Create, reabsorb, and model bone
Skin cell	Keratinocytes, melanocytes, Langerhans cell, Merkel cell	Create a protective barrier, protect against infection, produce skin pigmentation
Endothelial cell	Lining of blood vessels	Reinforces and grows blood vessels
Epithelial cell	Lining of body cavities	Aids in nutrient absorption, sensory detection; secretes mucus, hormones, or enzymes
Adipose cell	Adipocytes	Stores energy
Sex cell	Spermatozoa (sperm), ova (egg)	Human reproduction

TISSUES

Human tissues are groups of cells with similar form and function working together to perform a function within the body. There are four main tissue types in the human body: epithelial, connective, muscle, and nervous tissues.

Figure 2.4 Types of Tissues.



DID YOU KNOW:

The longest cells in the human body are motor neurons? These can be as long as 4.5 feet (1.37 meters) in length. The largest human cell is a fertilized egg.

Epithelial Tissue

Epithelial cells line the cavities of the body, and epithelial tissue does the same. Sheets of epithelial cells form the **epidermis** skin layer and line the gastrointestinal, respiratory, urinary, and reproductive tracts. These cells are constantly being replaced to maintain the protective layer through a process called **epithelialization**.

Epithelial tissue is defined by the type of epithelial cell(s) it contains. These cells can be classified as **squamous**, **cuboidal**, or **columnar**, but many more complex types exist. Squamous epithelial cells are thin and flat and can allow molecules to easily pass through. They are part of the lining of the lymphatic and cardiovascular systems, alveoli of the lungs, kidney tubules, and capillaries. Cuboidal epithelial cells are box shaped and actively secrete and absorb. They are found in the kidney tubules and gland ducts. Columnar epithelial cells are rectangular and are typically in a basal layer. They absorb and secrete molecules and can be found in the female reproductive tract and in the digestive tract.

EPIDERMIS:

The outermost layer of skin.

EPITHELIALIZATION:

The process of replacing epithelial cells to maintain a protective barrier.

SQUAMOUS:

Thin, flat epithelial cells allowing molecules to easily pass through.

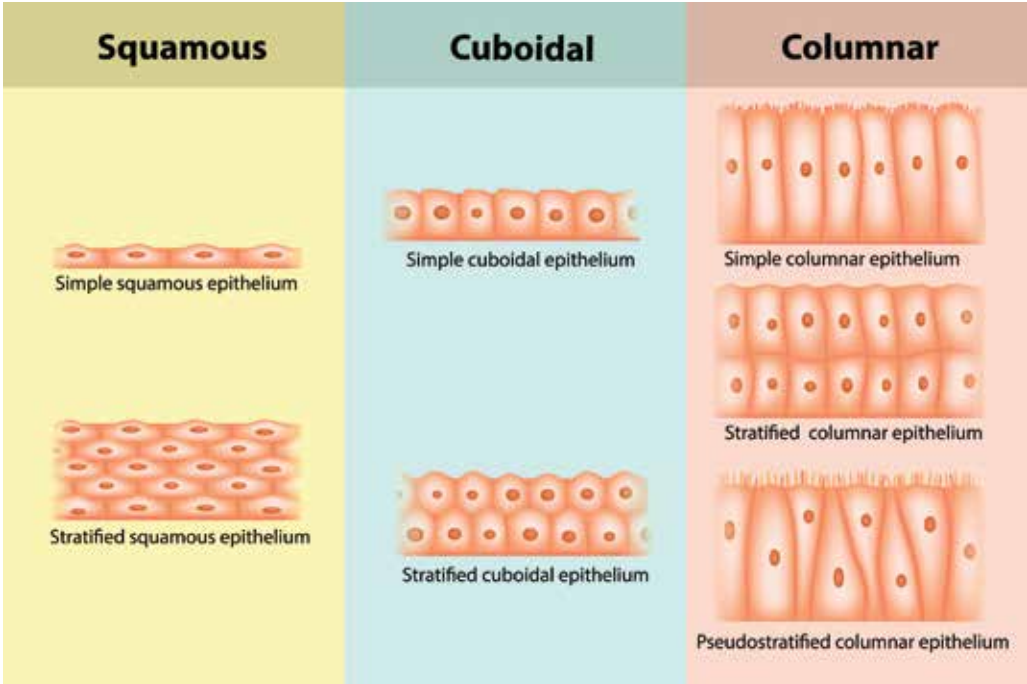
CUBOIDAL:

Box-shaped epithelial cells that secrete and absorb.

COLUMNAR:

Rectangular-shaped epithelial cells that secrete and absorb in a basal layer.

Figure 2.5 Types of Epithelial Cells.



**TRANSITIONAL
EPITHELIUM:**

Epithelial cells that can change shape or stretch.

**GLANDULAR
EPITHELIUM:**

Epithelial cells secreting specific water-based fluid, often containing proteins.

CONNECTIVE TISSUE:

Tissue supporting, binding, or connecting other tissues in the body.

The simple epithelial cells are in a single layer, while stratified cells create layers.

Outside the simple or stratified epithelial cells, **transitional epithelium** and **glandular epithelium** cell types also play a large role in the body. Transitional epithelial cells can change their shape as in the bladder. Glandular epithelial cells are a part of endocrine and exocrine glands, which secrete substances like breast milk, saliva, and hormones.

Connective Tissue

Connective tissue is any tissue serving to support, connect, or bind other tissues in the body. It is divided into three main categories: loose connective tissue, dense connective tissue, and specialized connective tissue.

Loose connective tissue is made of collagen, elastin, and reticular fibers, and it holds organs in place. Dense connective tissue is made of the same components and makes up tendons and ligaments connecting muscle to bone and bone to bone. Specialized connective tissue serves specific purposes and includes a variety of forms: adipose (fat) tissue cartilage, bone, blood, and lymph fluid.

Figure 2.6 Types of Connective Tissue.



Muscle Tissue

There are three types of muscle tissue in the human body: skeletal, cardiac, and smooth. The most common of these types is **skeletal muscle**, which is responsible for voluntary contraction and represents about 40 percent of the human body mass.

Smooth muscle, while not as abundant as skeletal muscle, plays a much larger role in human function. It is responsible for the involuntary muscle contractions in every organ system, ranging from uterine contractions and vascular resistance to digestion and secretion.

Cardiac muscle is unique in the way it contracts. Also involuntary, cardiac muscle is found only in the heart and contains branched and **striated muscle** fibers allowing for the propagation of signals through the individual cells.

SKELETAL MUSCLE:

Muscle fibers responsible for voluntary muscle contraction.

SMOOTH MUSCLE:

Muscle fibers responsible for involuntary muscle contraction in the organ systems.

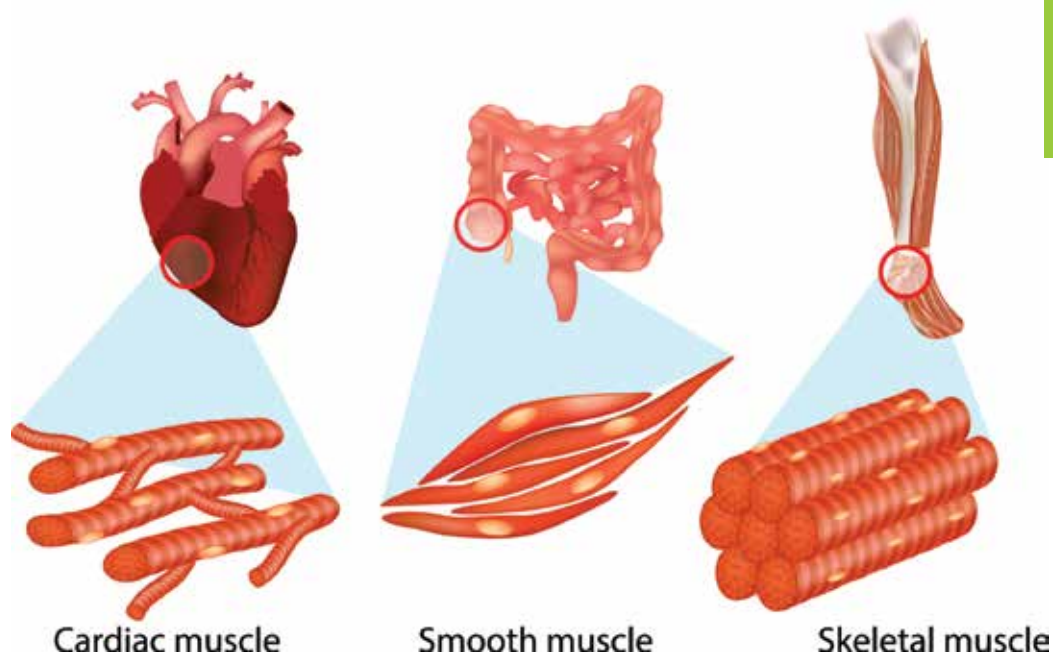
CARDIAC MUSCLE:

Muscle tissue found only in the heart.

STRIATED MUSCLE:

Muscle fibers having contractile units running parallel, appearing striped on a microscope.

Figure 2.7 Types of Muscle Tissue.



NERVOUS TISSUE:

The cells of the nervous system controlling body movement and body functions.

NERVE CELLS:

The neurons transmitting nerve signals.

NEUROGLIAL CELLS:

Nervous tissue found largely in the central nervous system that forms myelin, protects and supports neurons, and maintains homeostasis.

EFFERENT NERVES:

Nerve cells carrying a signal from the brain to the body (motor).

AFFERENT NERVES:

Nerve cells carrying a signal from the body to the brain (sensory).

CENTRAL NERVOUS SYSTEM (CNS):

The brain and the spinal cord.

PERIPHERAL NERVOUS SYSTEM (PNS):

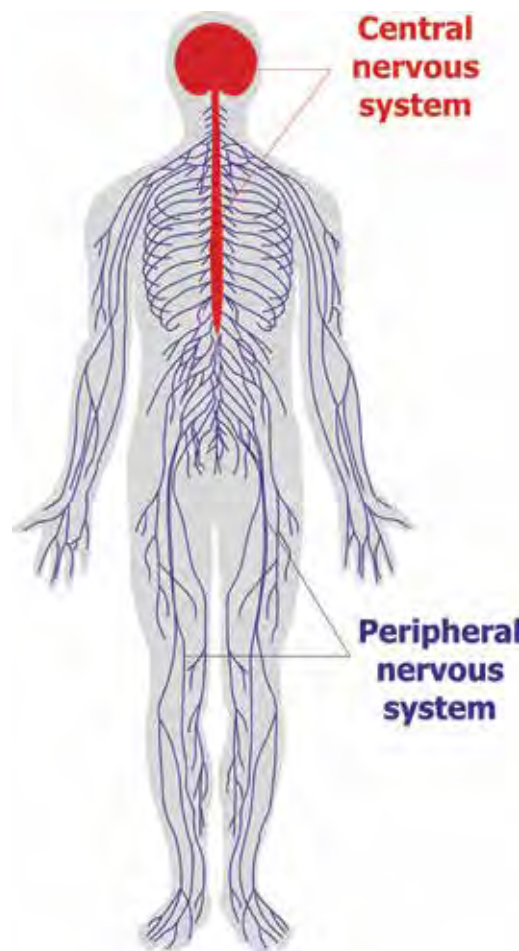
The nervous system outside the brain and spinal cord.

Nervous Tissue

Nervous tissue encompasses the cells of the nervous system controlling body movement and body functions. The **nerve cells** and **neuroglial cells** are included in nervous tissue. Nerve cells are often referred to as neurons, and they propagate signals from the brain to the body, called **efferent nerves** or motor neurons, and from the body to the brain, called **afferent nerves** or sensory neurons.

Neuroglial cells are found in the **central nervous system (CNS)**, which consists of the brain and the spinal cord. Nerve cells can extend beyond the CNS into the **peripheral nervous system (PNS)** to reach the extremities. The neuroglial cells do not propagate nerve signals but serve to protect neurons, form new myelin, and maintain homeostasis.

Figure 2.8 CNS and PNS.



DID YOU KNOW?

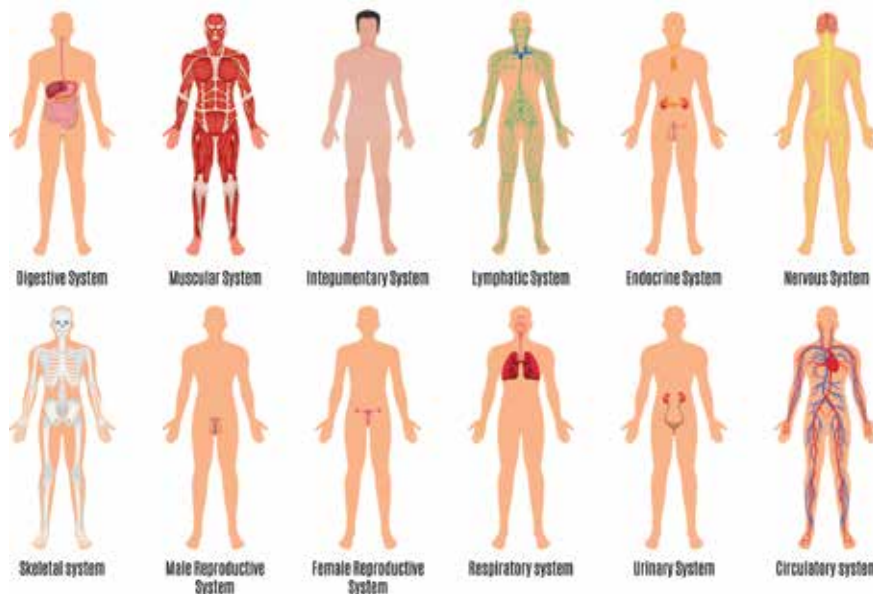
The average adult body makes between 50 and 70 billion new cells of various types every day? This is to accommodate for the natural death or loss of the same number of cells every 24 hours.

The cells in the body that have the shortest life span are the epithelial cells in the intestines, while sperm cells, the male sex cells, can live more than 60 days inside the body and up to 3 days outside the body.

ORGANS AND ORGAN SYSTEMS

There are 11 major organ systems in the human body working together to produce movement and function. Each is separated from the next, but their functions and actions are often intertwined. Dysfunction in one system will often affect other organ systems.

Figure 2.9 Organ Systems in the Human Body.



DID YOU KNOW:

There are 11 organ systems in the human body, consisting of 78 individual organs?

Integumentary System

The **integumentary system** is the largest organ system covering the entire human body and is made up of skin, hair, and nails. This system protects the internal organ systems from damage and disease, prevents water and fluid loss, and regulates body temperature. The layers of the skin also include the exocrine glands and sensory nerves.

INTEGUMENTARY SYSTEM:

Organ system protecting the body; composed of skin, hair, and nails.

EPIDERMIS:

The external layer creating a waterproof barrier and giving the skin its physical tone.

DERMIS:

the skin layer below the epidermis containing hair follicles, connective tissue, sweat glands, blood vessels, and lymph vessels.

HYPODERMIS:

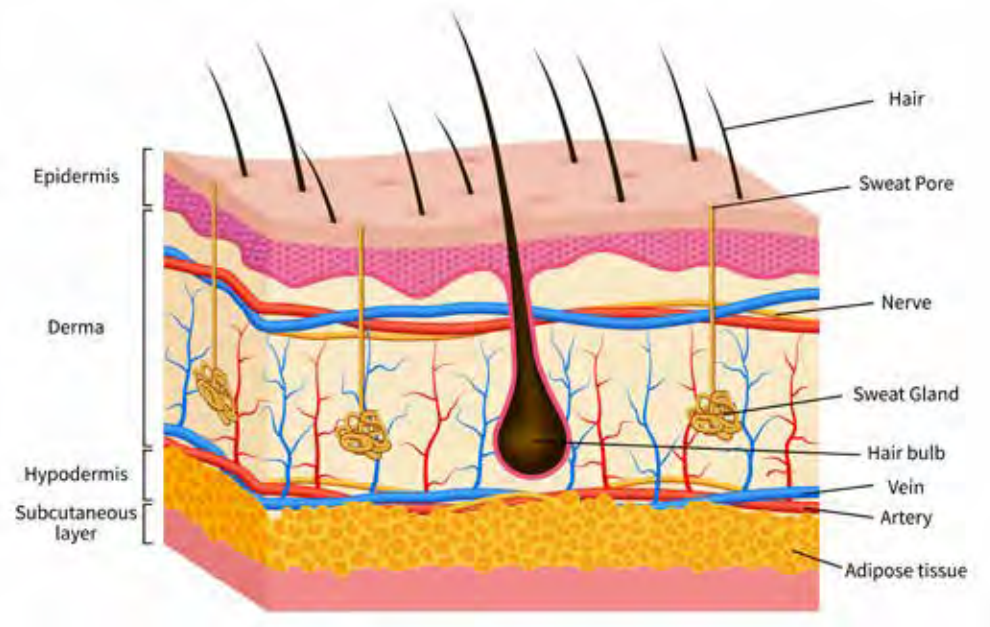
The third skin layer made of adipose and connective tissue.

SUBCUTANEOUS LAYER:

The skin layer serving to insulate; technically part of the hypodermal layer.

Three layers make up the skin: the **epidermis**, **dermis**, and **hypodermis**, which is sometimes referred to as the **subcutaneous layer**. The epidermis is the external layer creating a waterproof barrier and giving the skin its physical tone. The dermis is just below the epidermis and contains hair follicles, connective tissue, sweat glands, blood vessels, and lymph vessels. Below the dermis is the hypodermis, which is made up of adipose and connective tissue. The subcutaneous layer serves to insulate and is technically part of the hypodermal layer.

Figure 2.10 Skin Layers.



Muscular System

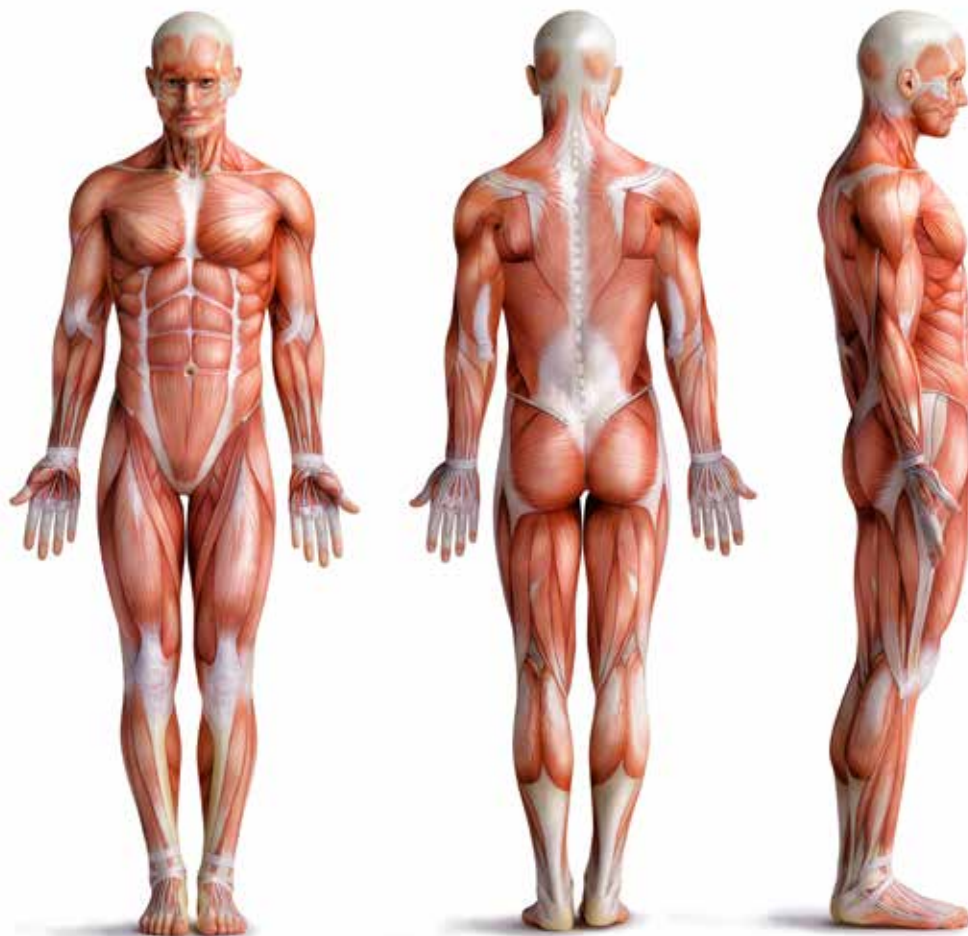
The **muscular system** is the collection of the muscle fibers throughout the human body with the main function of contractibility. Muscles—big and small—are responsible for the movement of the human body but also posture, the stability of joints, and heat production.

The muscular system consists of three muscle tissue types: cardiac, smooth, and skeletal muscle. Skeletal muscle is the most prominent by mass, but smooth muscle has the largest amount of function in the body. Smooth muscle is found in all hollow organs, such as blood vessels, the intestines, the bladder, and the uterus in females. It is important to distinguish among the tissue types, as skeletal muscle is voluntarily contracted and can therefore be trained with physical activity, while cardiac and smooth muscle are involuntarily contracted. All three tissue types require balanced nutrition for longevity.

MUSCULAR SYSTEM:

The collection of the muscle fibers throughout the human body with the main function of contractibility.

Figure 2.11 Skeletal Muscle of the Human Body.



Skeletal muscle is classified and named by factors such as the size, shape, location, and action of the muscle.

Table 2.3 Factors for Naming Skeletal Muscle.

FACTOR	EXAMPLES
Size	Vastus, huge Maximus, large Longus, long Minimus, small Brevis, short
Shape	Deltoid, triangular Rhomboid, like a rhombus Latissimus, wide Teres, round
Direction of fibers	Rectus, straight Transverse, across Oblique, diagonal
Location	Pectoral, chest Gluteus, buttocks Brachii, arm Lateralis, lateral
Number of origins	Biceps, two heads Triceps, three heads Quadriceps, four heads
Origin and insertion	Brachioradialis, origin on the brachium (arm), insertion on the radius
Action	Levator, lift Flexor, to flex Extensor, to extend

Skeletal System

VERTEBRATES:

Animals with a vertebral column or spine.

Humans are **vertebrates**—animals with a vertebral column or spine. The skeletal system consists of bones, cartilage, ligaments, and tendons, which are all connective tissues, and accounts for about 20 percent of the human body mass. Its purpose is to provide a framework to protect the soft organs inside the body and protect the nervous system components, including the brain and spinal cord, from damage.

Bones contain more calcium than any other organ in the body, and they consume oxygen and nutrients, create metabolic waste, and require blood supply. These processes allow bone to actively grow, remodel, and respond to the physical stresses placed on the body.

The skeleton can be divided into the **axial skeleton** and the **appendicular skeleton**. The axial skeleton is made up of 80 bones in the adult human and includes the bones of the vertical axis of the body, such as the sternum, cranium, and vertebral column. The appendicular skeleton is made up of 126 bones and includes the bones of the appendages attaching to the axial skeleton.

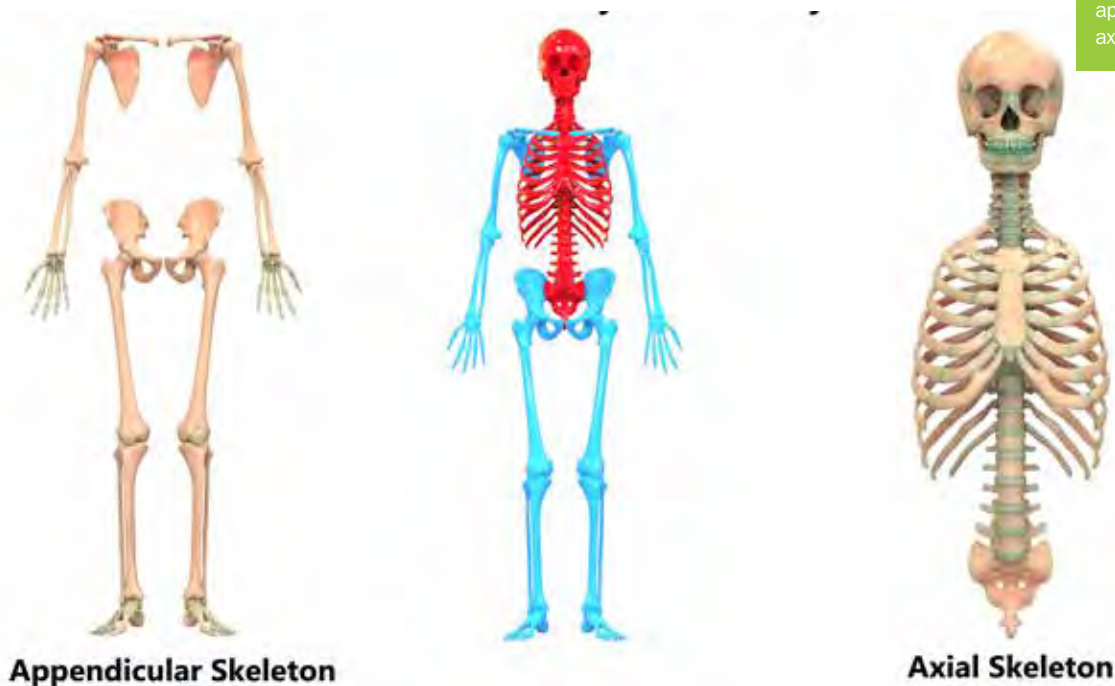
AXIAL SKELETON:

Made up of 80 bones in the adult human and includes the bones of the vertical axis of the body, such as the sternum, cranium, and vertebral column.

APPENDICULAR SKELETON:

Made up of 126 bones and includes the bones of the appendages attaching to the axial skeleton.

Figure 2.12 Appendicular and Axial Skeletons.

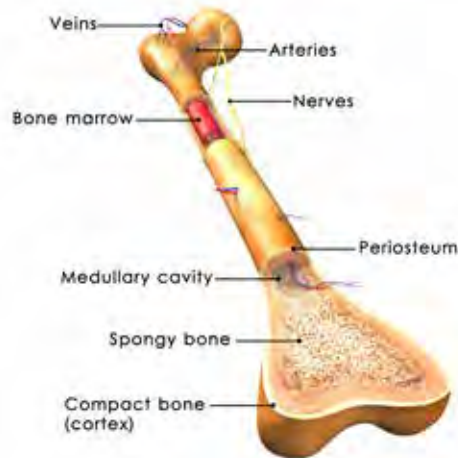


There are several types of bones within the skeletal system that are generally named for their appearance.

Figure 2.13 Types of Bones.



Figure 2.14 Anatomy of Bone.



- Bone marrow generates stem cells and produces red blood cells.
- Spongy bone is a porous and highly vascular bone near the ends of long bones.
- Compact bone is a dense, hard bone providing structure.
- Medullary cavity is the central cavity through the bone shaft storing bone marrow and is known as the marrow cavity.
- Periosteum is the vascular connective tissue layer covering bones except for the surfaces of joints.

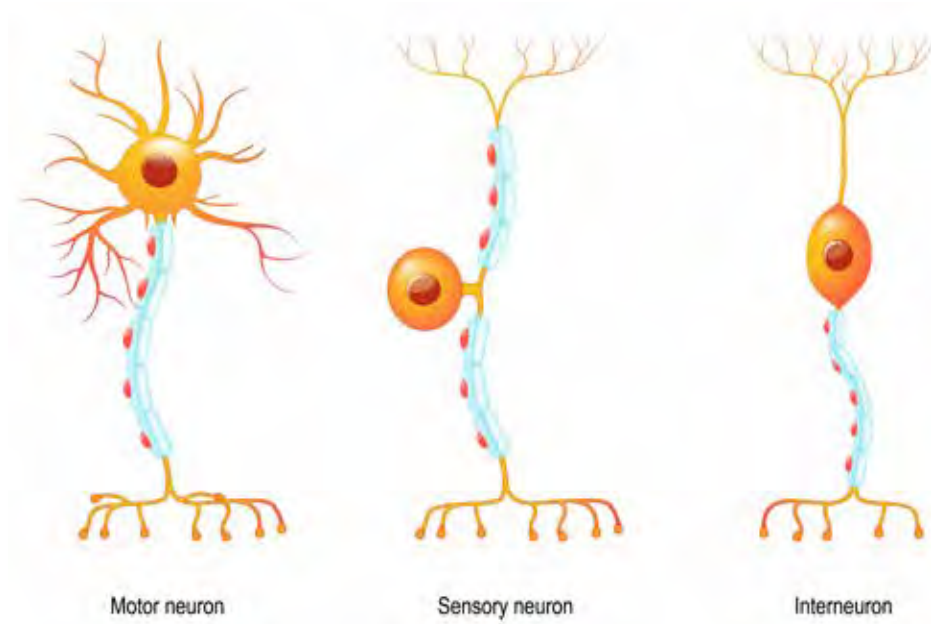
Nervous System

The nervous system allows the body to communicate with, control, and regulate the other organ systems for proper body function. The CNS and PNS provide all the sensory and motor neurons needed to transmit electrical signals throughout the body that are translated into movement. **Interneurons** help to transmit impulses between neurons within the nervous system.

INTERNEURONS:

A neuron with its cell body, axon, and dendrites located entirely within the CNS.

Figure 2.15 Neuron Types.



SOMATIC NERVOUS SYSTEM:

The system carrying impulses to and from the skeletal muscle, through the spinal cord, and to or from the brain, which allows the body to react to the external environment.

AUTONOMIC NERVOUS SYSTEM:

Involuntary and controls the internal organs, including the heart and lungs as well as glands.

The motor neurons of the PNS are broken down into the **somatic nervous system** and the **autonomic nervous system**. The somatic nervous system carries impulses to and from the skeletal muscle, through the spinal cord, and to or from the brain and allows the body to react to the external environment. The autonomic nervous system is completely involuntary and controls the internal organs, including the heart and lungs as well as glands. This system is responsible for what is called “rest and digest.”

Circulatory System

The **circulatory system** circulates blood within the vascular system around the body and consists of the heart, arteries, veins, capillaries, and blood. This is a closed system, meaning the fluid stays within the organ system. The main function of the circulatory system is to transport oxygen from the lungs to the body tissues and metabolic waste, in the form of carbon dioxide, in the opposite direction.

DID YOU KNOW:

The eye is considered an organ that is part of the nervous system?

CIRCULATORY SYSTEM:

An organ system consisting of the heart, blood vessels, and blood.

ARTERIES:

Blood vessels carrying oxygenated blood away from the heart and to the tissues.

VEINS:

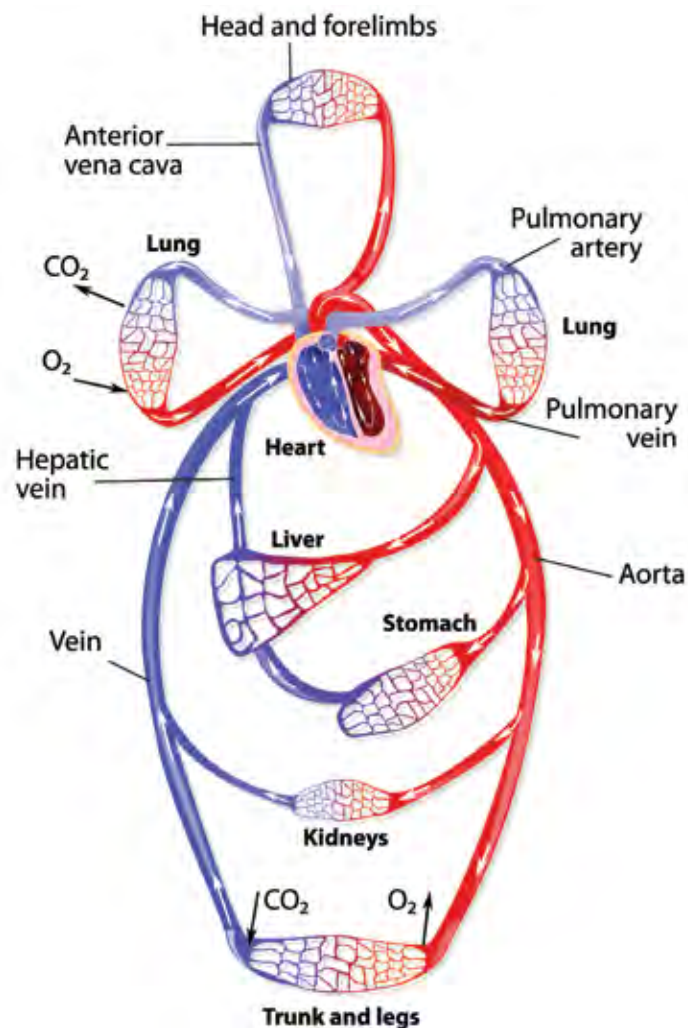
Blood vessels carrying blood toward the heart to remove waste and pick up more oxygen.

CAPILLARIES:

Fine-branching blood vessels forming a network between the arterioles and venules, where transport of nutrients and oxygen or carbon dioxide occurs on a microscopic scale.

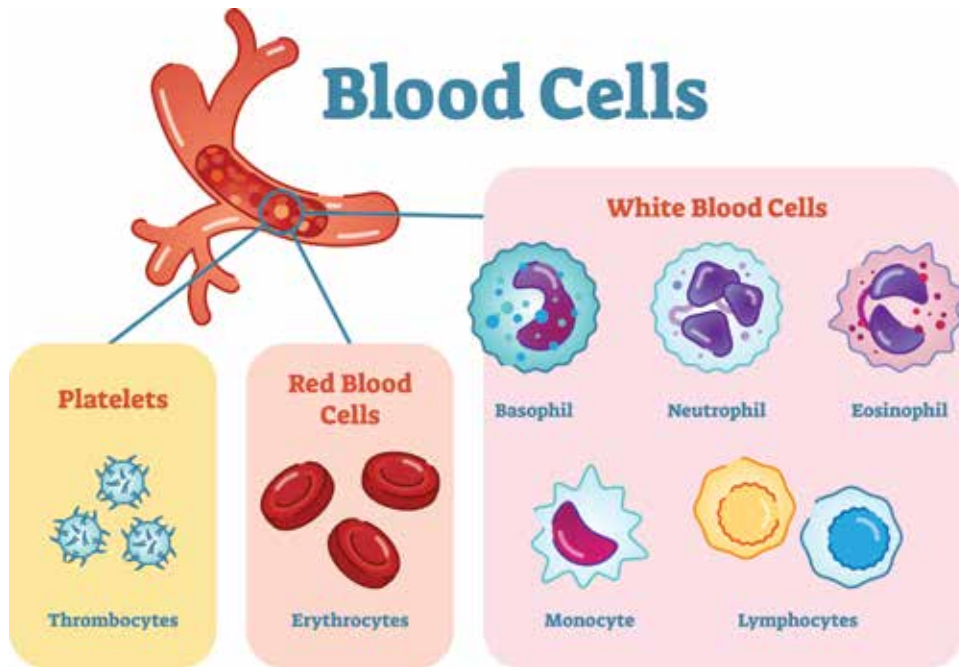
The circulatory system is also important for the transport of nutrients from the digestive system to body tissues and for waste clearance resulting from physical activity such as weight training or aerobic exercise. The **arteries** carry oxygenated blood away from the heart and to the tissues, **veins** carry blood toward the heart to remove waste and pick up more oxygen, and **capillaries** transport nutrients and oxygen or carbon dioxide on a microscopic scale.

Figure 2.16 Circulatory System.



Blood and platelets are circulated in the circulatory system along with the cells that are responsible for immunity. These connective tissues aid in the transfer of oxygen and carbon dioxide, allow for blood clotting in the event of an injury or integument breach, and trap and kill foreign bodies.

Figure 2.17 Types of Blood Cells in the Circulatory System.



DID YOU KNOW?

Did you know the adult human body can manufacture up to 17 million red blood cells per second? That is small potatoes when considering the fact that there are around 150 billion red blood cells in a single ounce of blood.

Lymphatic System

The **lymphatic system** is often forgotten but plays several major roles in the body. First, **lymph nodes** are organs within this system that filter and remove foreign particles from circulation in the body. **Lymphocytes** consume and destroy foreign bacteria and viruses as part of the immune system.

Second, the lymphatic system aids in filtering excess fluid from the spaces between cells known as **interstitial space**. About 90 percent of the fluid exiting the capillaries into tissue is returned via the circulatory system or the lymphatic system. The remaining 10 percent of fluid remains in the interstitial or cellular spaces.

Third, the lymphatic system is used to absorb fats and fat-soluble vitamins from the digestive system with the aid of specialized vessels in the lining of the intestines.

LYMPHATIC SYSTEM:

The organ system working in conjunction with the circulatory and immune systems to prevent disease and maintain fluid balance.

LYMPH NODES:

Lymphatic organs that filter and remove foreign particles.

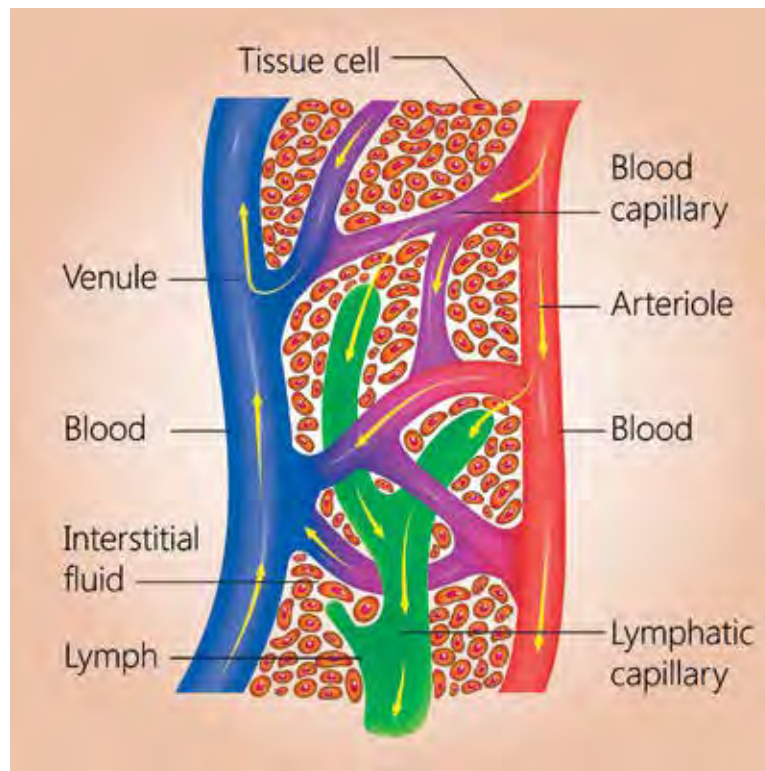
LYMPHOCYTES:

Lymphatic bodies within lymph nodes that consume foreign bodies.

INTERSTITIAL SPACE:

The space between cells.

Figure 2.18 The Relationship between the Lymphatic and Circulatory Systems.



The lymphatic system is heavily intertwined with the circulatory system and regulates fluid volume in the interstitial space and in the blood vessels.

RESPIRATORY SYSTEM:

The organ system responsible for respiration—internal and external—and gas exchange.

INTERNAL RESPIRATION:

The exchange of gases between blood and tissues.

CELLULAR METABOLISM:

The use of oxygen within cells for specific activities.

VENTILATION:

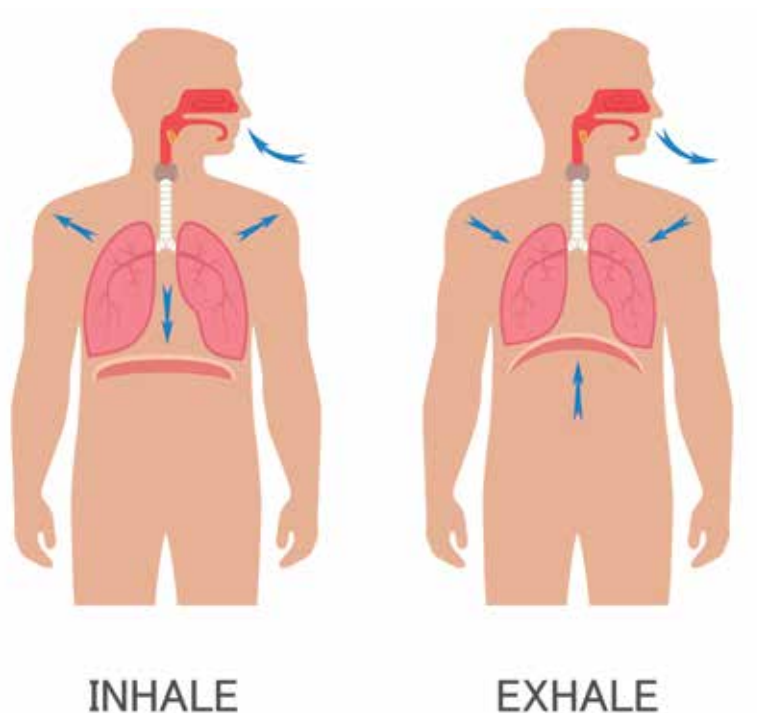
Breathing; inhalation and exhalation.

Respiratory System

The **respiratory system** is often mistaken for the circulatory system, but it is an entirely separate organ system. The respiratory system is responsible for breathing, oxygen supply, and gas exchange at a cellular level known as **internal respiration**. Gas exchange within cells for specific activities is referred to as **cellular metabolism**, and all are included in the overarching term “respiration.”

Inhalation and exhalation, or breathing in and out, are controlled by the autonomic nervous system and occur every three to five seconds when an adult human is at rest. The process is called **ventilation** and will become more rapid when the energy needs of the body or activity levels increase to support the oxygen demands of the cells and tissues. This process is made possible with cooperation from the nervous system and the muscular system.

Figure 2.19 Ventilation.



To inhale, the diaphragm is pulled downward to expand the lungs and pull air into the airway. Upon exhalation, the diaphragm is pushed upward, compressing the lungs and forcing air out of the airway.

Endocrine System

The **endocrine system** works closely with the nervous system to produce, release, and regulate chemical messengers called **hormones** in the body. Hormones affect the growth, development, and metabolic activity of tissues throughout the body. The two main categories of glands in the endocrine system are **exocrine glands** and **endocrine glands**.

Exocrine glands, such as sweat glands or mammary (milk) glands, have ducts that carry secretions to the surface. Endocrine glands are ductless glands of the endocrine system with secretions (hormones) moving directly into the bloodstream to be carried throughout the body.

ENDOCRINE SYSTEM:

The organ system producing, releasing, and controlling hormones.

HORMONES:

Chemical messengers in the body affecting growth, development, and metabolic activities.

EXOCRINE GLANDS:

glands of the endocrine system that have ducts carrying secretions to the surface.

ENDOCRINE GLANDS:

Ductless glands of the endocrine system with secretions moving directly into the bloodstream to be carried throughout the body.

Table 2.4 Endocrine Glands and Their Hormones.

GLAND	LOCATION IN BODY	HORMONE(S) PRODUCED	FUNCTION(S)
Adrenals	On each kidney	Adrenalin	Regulates blood pressure, “fight or flight”
Pituitary	Base of the brain	Growth hormone, oxytocin	Regulates growth, stimulates uterine contraction in pregnant women
Thyroid	Front of neck below larynx	Thyroxin	Regulates metabolic rate and growth
Pancreas	Below stomach	Insulin, Glucagon	Controls carbohydrate metabolism, regulates sugar from the liver
Ovaries	Abdomen	Estrogen, Progesterone, Relaxin	Develops female sex organs and characteristics, attaches fetus to uterine wall, widens the pelvis for birth
Testes	Scrotum	Testosterone	Develops male sex organs and characteristics

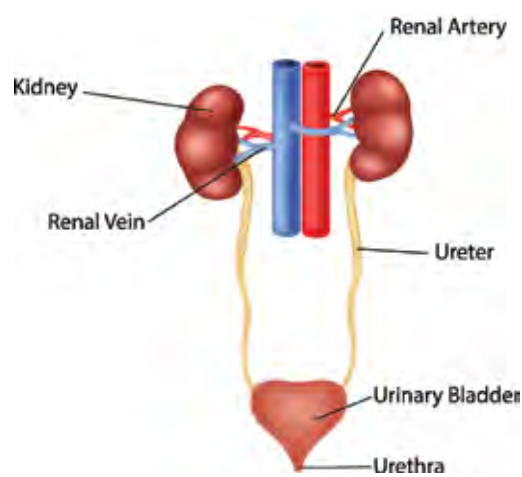
URINARY SYSTEM:

The organ system producing, storing, and eliminating fluid waste or urine.

Urinary System

The **urinary system** excretes metabolic waste and maintains internal fluid levels within a normal range. The specific organs involved include the kidneys, ureters, bladder, and urethra.

Figure 2.20 Urinary System.



The kidneys have a complex system of funnels and tubules filtering about 200 quarts of blood and fluid daily, with the goal of removing waste, excess ammonia, and excess water from the body. Some of the fluid filtered by the kidneys is reabsorbed by the body, especially in the event of dehydration. Fluid that is not reabsorbed into the bloodstream is called urine and is collected in the urinary bladder and held before being expelled.

Reproductive System

The **reproductive system** is different in males and females, but both systems have the same ultimate purpose: procreation. The reproductive system has four major functions:

- 1 Produce sperm and ova
- 2 Transport and sustain sperm and ova
- 3 Grow and develop offspring (females)
- 4 Produce sex hormones

The primary organs of the reproductive system are the ovaries and testes, referred to as the **gonads**. They are mixed glands that produce the gametes (sex cells) and sex hormones of an organism. All other organs, ducts, and glands associated with the reproductive system are accessory reproductive organs.

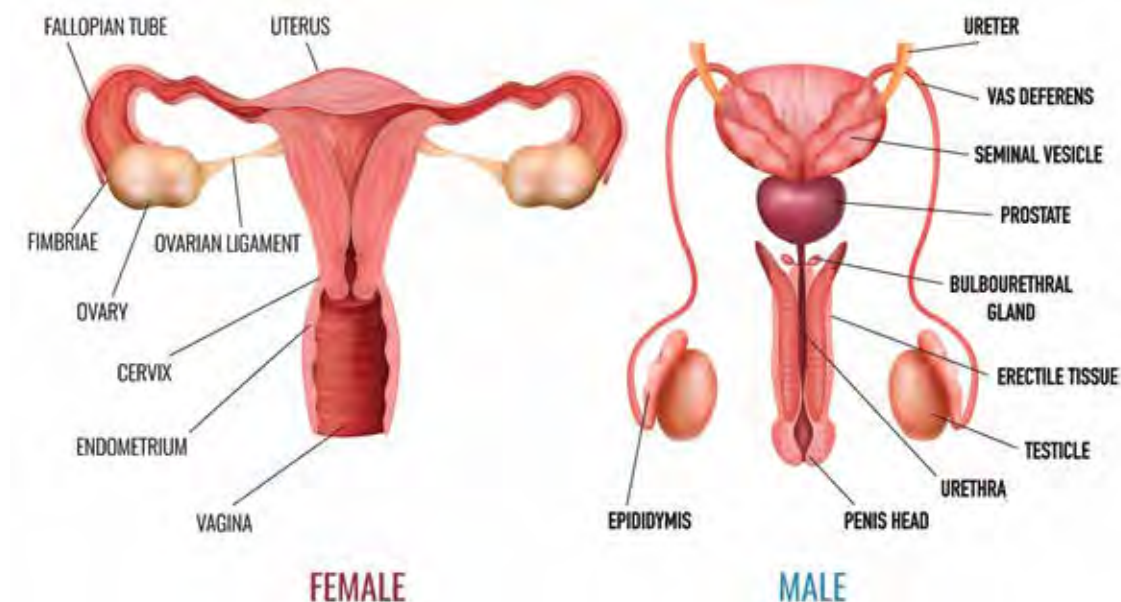
REPRODUCTIVE SYSTEM:

The organ system responsible for human reproduction.

GONADS:

The primary reproductive organs, the ovaries and testes, that produce the gametes (sex cells) and sex hormones of an organism.

Figure 2.21 The Human Reproductive System.



Digestive System

GASTROINTESTINAL (GI) TRACT:

The part of the human digestive system consisting of the stomach and intestines.

The digestive system breaks down food into smaller molecules for use on the cellular level. Referred to as the **gastrointestinal (GI) tract**, the digestive system has six functions responsible for breaking down food for energy:

- 5 Ingestion: taking food in through the mouth
- 6 Mechanical digestion: chewing (mastication) and the churning and mixing actions of the stomach that further break down food
- 7 Chemical digestion: breaking food down further via enzymes released into the stomach mixed with water
- 8 Movements: moving food through the digestive system by the rhythmic contractions of the smooth muscle of the digestive tract, a process known as peristalsis
- 9 Absorption: absorbing simple molecules by the cell membranes in the lining of the small intestine and moving into blood or lymph capillaries
- 10 Elimination: removing waste products and indigestible particles

The digestive tract—beginning at the mouth and ending at the anus—is between four and six meters long. Unlike the circulatory system, which is a closed system, the digestive tract is an open system with openings at both ends.

MUCOSA:

Innermost lining of the digestive tract in contact with food.

MUSCULARIS MUCOSA:

Smooth muscle in the GI tract moving food through.

PERISTALSIS:

The systematic series of smooth muscle contractions that move food through the GI tract.

SUBMUCOSA:

The layer of the GI tract with lymphatic and blood vessels and nerves.

SEROSA:

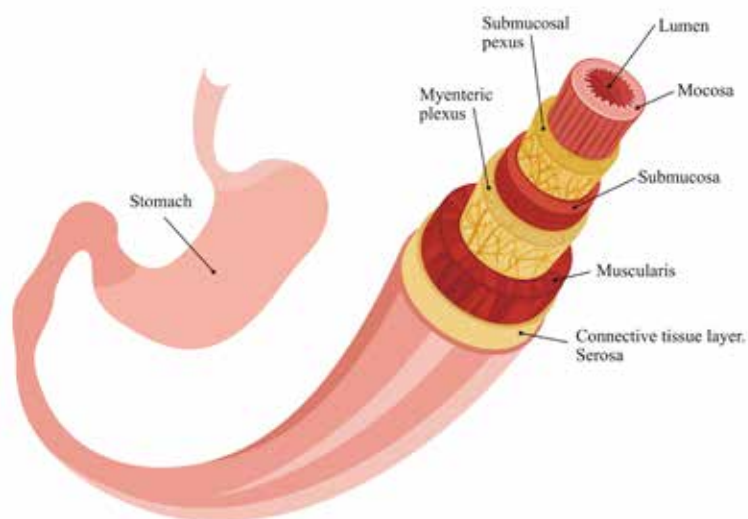
The outermost layer of the GI tract serving as a barrier.

The basic structure of the digestive tract includes four layers of specialized tissues. The **mucosa** lines the digestive tract and is in contact with the food that passes through. Cells within the mucosa secrete mucus, digestive enzymes, and hormones. The **muscularis mucosa** is a smooth muscle cell helping to move food along via **peristalsis**, a systematic series of muscular contractions to propel food through the GI tract.

The next layer is the **submucosa**, which has blood vessels, lymphatic vessels, and nerves. Next is the muscular layer made of smooth muscle tissue. The inner layer is made of cells arranged in a circular pattern, the outer layer with cells in a longitudinal pattern. The combined peristaltic action of these layers moves food through the digestive tract.

Finally, the **serosa** is the outermost layer of the digestive tract. It acts as a barrier between the internal organs and abdominal cavity and is made up of two layers. The first is connective tissue. The second is a thin layer of epithelial cells secreting serous fluid to reduce friction from muscle movements.

Figure 2.22 Layers of the GI Tract.



DID YOU KNOW:

There are five organs considered vital for human survival? These include the heart, brain, kidneys, liver, and lungs. If any of these five organs stops working, and there is no medical intervention, death is imminent.

Surrounding the lumen (open space) in the GI tract, the mucosa, submucosa, muscularis, and serosa create the functional layers of the digestive tract.

THE DIGESTIVE SYSTEM

The digestive system is the path through which all food passes to provide nutritional value to the cells. The process of food breakdown varies by macronutrient, but all food travels the same route through the digestive system.

ALIMENTARY TRACT

The digestive system is divided into the alimentary tract and accessory organs. The alimentary tract includes all the organs the food travels through.

Mouth

Ingestion and the beginning stage of mechanical digestion occur in the mouth. The salivary glands are accessory organs. **Saliva** contains water, mucus, and the enzyme **amylase**. Amylase begins the process of breaking down starches. The saliva also cleanses the teeth, wets food for swallowing, and dissolves certain molecules for taste.

Pharynx

Also known as the throat, the **pharynx** is a passageway transporting food, water, and air.

SALIVA:

Fluid from the mouth containing water, mucus, and amylase.

AMYLASE:

An oral enzyme beginning the process of starch breakdown.

PHARYNX:

The throat.

ESOPHAGUS:

The piece of the alimentary tract connecting the throat to the stomach.

STOMACH:

The muscular pouch used for mechanical and chemical digestion in the alimentary tract.

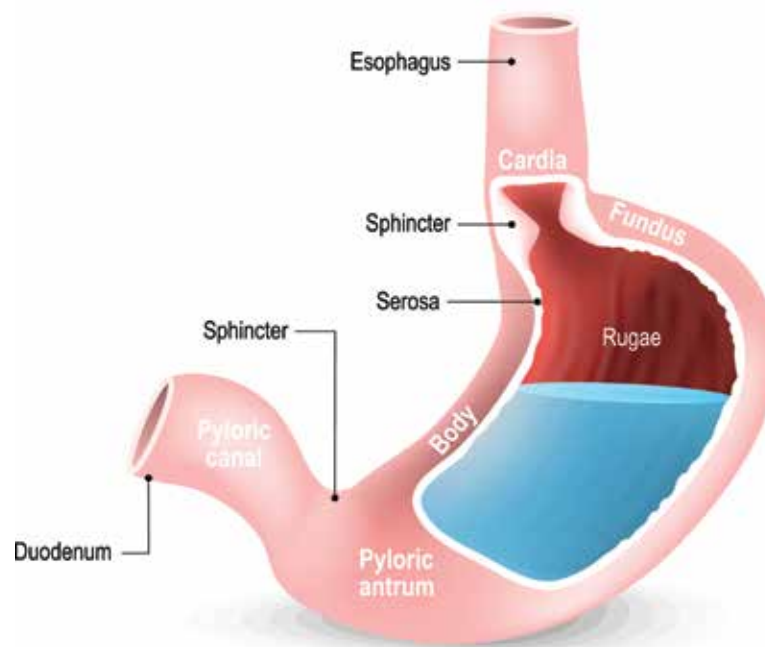
Esophagus

Food travels from the pharynx into the **esophagus** with the action of swallowing. From the esophagus, food enters the stomach.

Stomach

The **stomach**, found in the upper-left portion of the abdominal cavity, aids in both mechanical and chemical digestion. It is divided into four regions: the fundic, cardiac, body, and pyloric regions.

Figure 2.23 Regions of the Stomach.



GASTRIN:

A hormone-stimulating secretion of gastric juice; secreted into the bloodstream by the stomach wall in response to food.

From top to bottom—the cardia, fundus, body, and pyloric regions of the stomach are shown.

Gastric juices, which are acids helping to chemically digest food, are made constantly but are either upregulated or downregulated by the hormone gastrin. The process of digestion is controlled by **gastrin** in three different phases:

- 1 Thoughts and smells of food begin the cephalic phase of gastric excretion.
- 2 The gastric phase begins when food particles enter the stomach.
- 3 Once the liquid, partially broken-down food, known as **chyme**, begins to exit the stomach and enter the small intestine, the intestinal phase of gastric excretion begins.

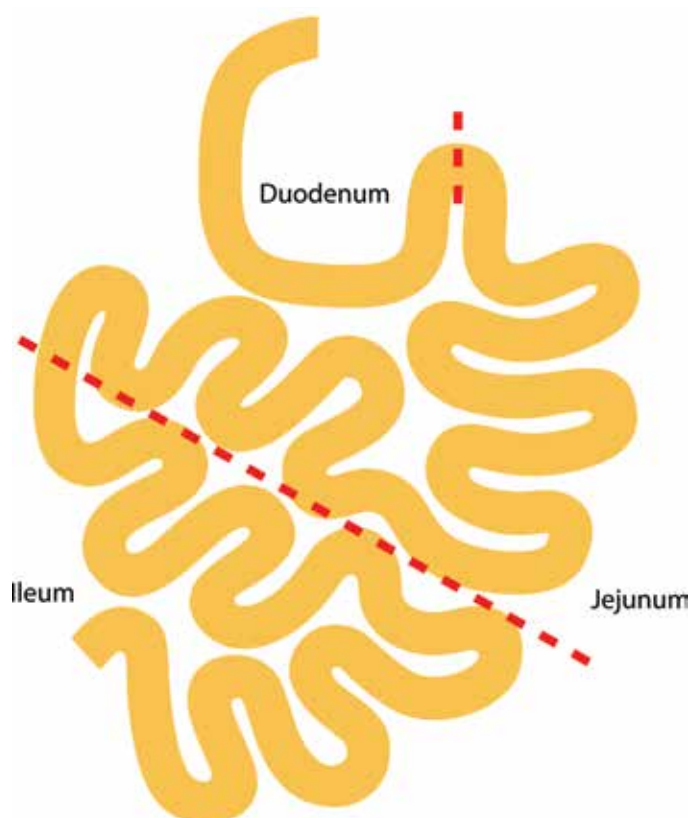
CHYME:

The pulpy, acidic fluid passing from the stomach to the small intestine, consisting of gastric juices and partially digested food.

Small Intestine

Most of the nutrients from food are absorbed into the body in the small intestine. It is divided into three sections in the following order: the duodenum, jejunum, and ileum.

Figure 2.24 Sections of the Small Intestine.



The duodenum is the shortest section of the small intestine, and it receives chyme from the stomach. It is responsible for chemically digesting the chyme to prepare for absorption in more distal areas of the small intestine. The jejunum absorbs fatty acids, sugars, and amino acids. The peristaltic movement of the smooth muscle is fast and strong in this region of the small intestine. Finally, the ileum is the last section of the small intestine before the cecum and is responsible for absorbing vitamin B12, bile salts, and anything missed by the jejunum. Most of the folded surfaces are found in the ileum for maximum surface area and absorption.

Absorption occurs via the **plicae circulares**, **villi**, and microvilli.

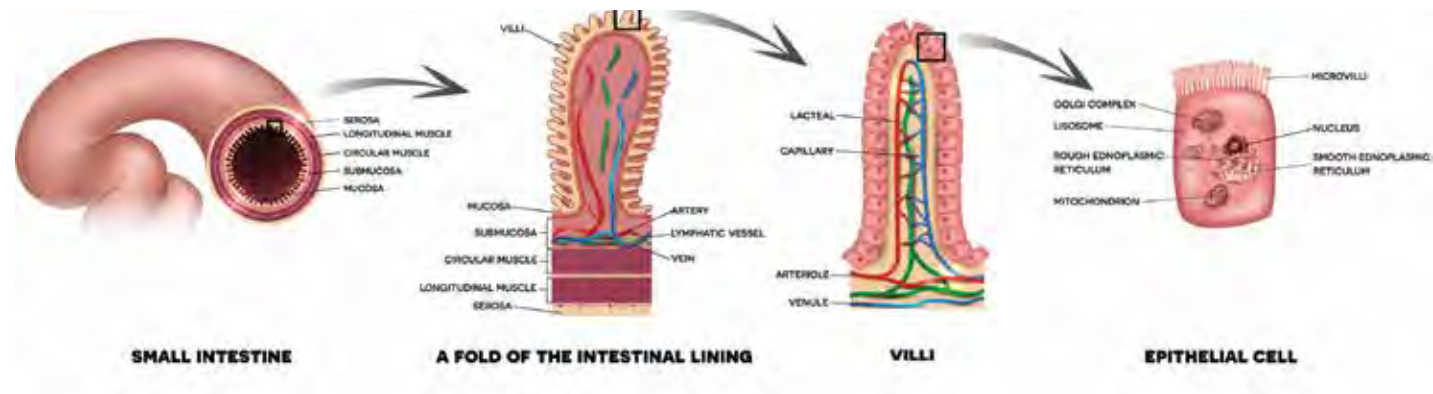
PLICAE CIRCULARES:

Crescent-shaped folds of the mucosa and submucosa.

VILLI:

Tiny hairlike projections often on the surface of mucous membranes.

Figure 2.25 Cells of the Small Intestine.



The folds of the small intestine are further folded into villi. The villi are further folded into microvilli, which absorb nutrients at a cellular level. The folds increase the surface area of the intestine. Both exocrine and endocrine cells support the digestive process in the small intestine.

Table 2.5 Exocrine Secretions and Functions.

SECRETION	FUNCTION
Enterokinase	Convert trypsinogen to trypsin to break down proteins
Lactase	Break down lactose
Lipase	Break down fatty acids
Maltase	Break down maltose to glucose
Mucus	Lubricate passageways for food to move easily
Peptidase or protease	Break down proteins
Sucrase	Break down sucrose to fructose and glucose

CHOLECYSTOKININ:

An endocrine secretion in the GI tract to digest proteins and fats.

SECRETIN:

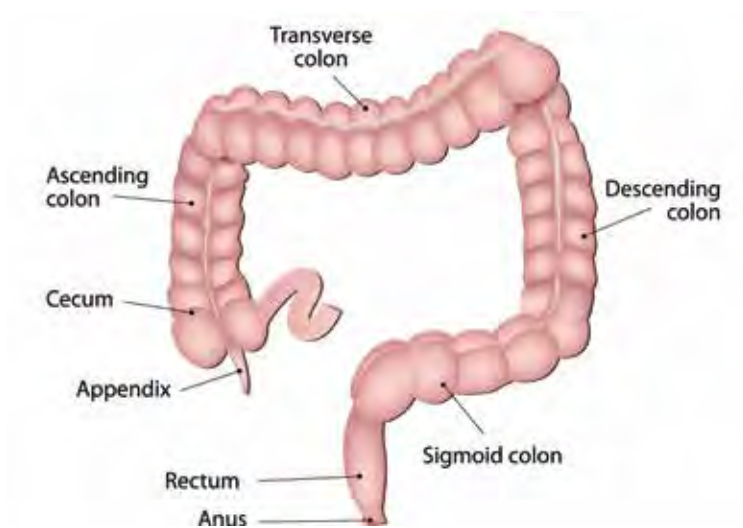
An endocrine secretion in the GI tract regulating water balance and pH in the duodenum.

The endocrine cells secrete **cholecystokinin** and **secretin**. Cholecystokinin helps digest proteins and fats. Secretin regulates water balance and pH within the duodenum.

Large Intestine

The small intestine meets the large intestine at the ileocecal junction. The large intestine is divided into the **colon** (ascending, transverse, descending, and sigmoid), **rectum**, and **anus**. The large intestine does not digest food or produce digestive enzymes. Rather, the large intestine absorbs water and electrolytes left over from digestion and pushes chyme along throughout the colon to be eliminated from the body.

Figure 2.26 Large Intestine.



COLON:

The longest part of the large intestine; removes water from waste matter.

RECTUM:

The space between the colon and anus where fecal matter is stored.

ANUS:

The opening at the end of the alimentary tract where waste exits the body.

Rectum and Anus

The rectum allows a space for fecal matter to be stored before it is eliminated from the body. The anus is the opening through which fecal matter exits. At each end of the anal canal are sphincters controlling the release of feces.

ACCESSORY ORGANS

The accessory organs are the organs supporting digestion but are not directly part of the digestive system.

Liver

The liver is the largest gland in the body. It receives oxygenated blood from the **hepatic artery** and nutrient-rich blood from the digestive tract through the **hepatic portal vein**.

HEPATIC ARTERY:

A short blood vessel supplying oxygenated blood to the liver, pylorus of the stomach, duodenum, pancreas, and gallbladder.

HEPATIC PORTAL VEIN:

Vein conveying blood to the liver from the spleen, stomach, pancreas, and intestines.

The liver serves many important functions, including the following:

- Secretion of plasma proteins, carrier proteins, hormones, prohormones, and apolipoprotein
- Making and excreting bile salts
- Storage of fat-soluble vitamins
- Detoxification and filtration
- Metabolism of carbohydrates, proteins, and fat

Gallbladder

Attached to the liver is the gallbladder for which the primary role is to store **bile** for use in digestion. Bile is made of water, bile salts, bile pigments, and cholesterol, and it helps in the digestion and absorption of fats.

BILE:

A bitter, greenish-brown alkaline fluid aiding in digestion; secreted by the liver and stored in the gallbladder.

Pancreas

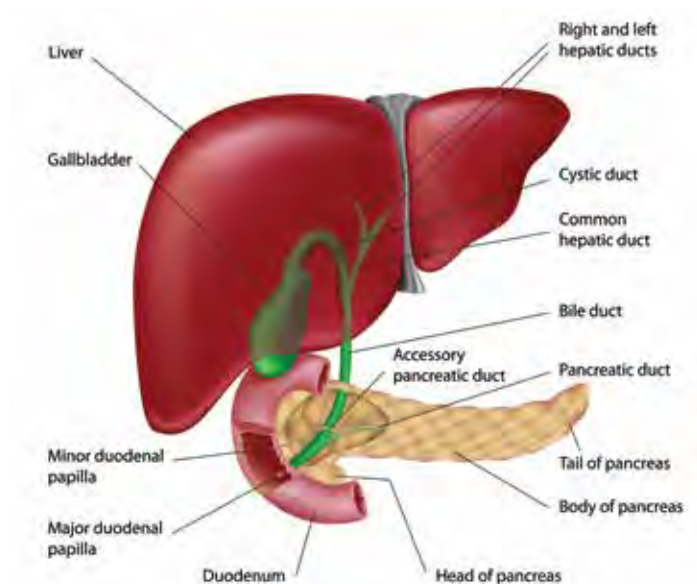
The pancreas is found behind the stomach and has both endocrine and exocrine functions in the body. It plays a major role in digestion by secreting the digestive enzymes amylase, trypsin, peptidase (protease), and lipase.

The **islets of Langerhans** are groups of specialized cells on the pancreas secreting the endocrine hormones insulin, glucagon, and somatostatin. Secretions of the pancreas are controlled by the hormones secretin and cholecystokinin.

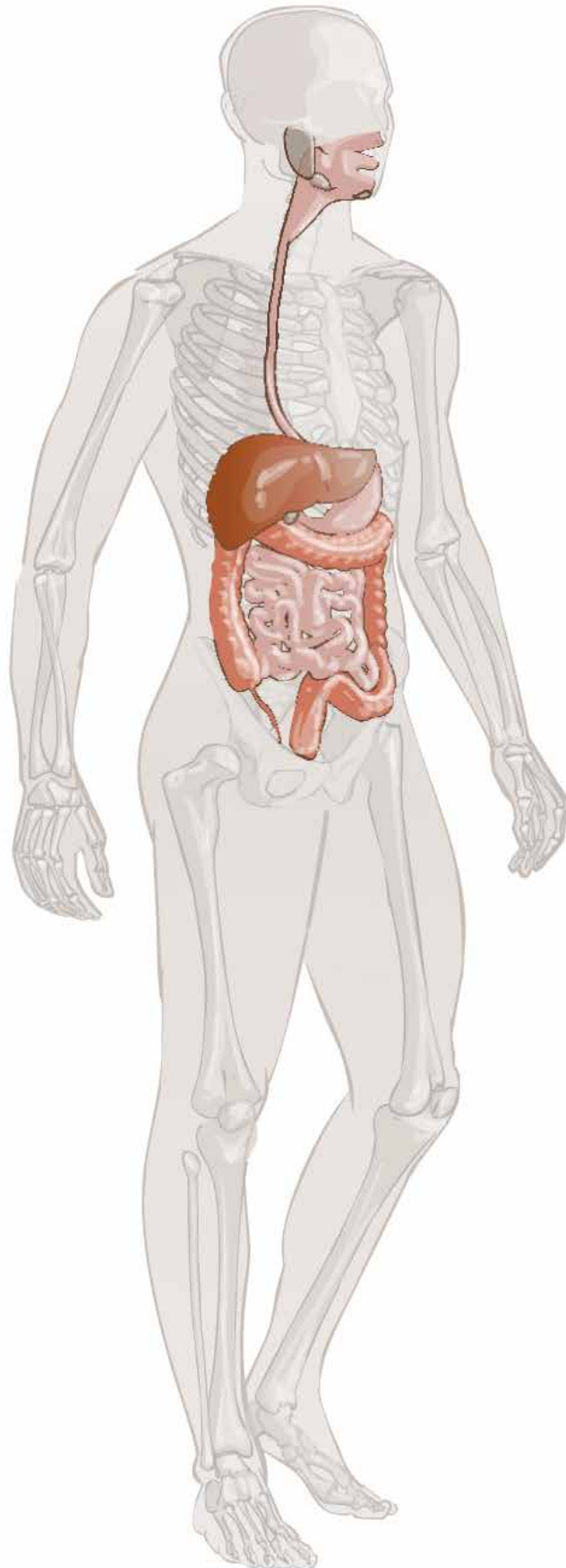
ISLETS OF LANGERHANS:

Specialized pancreatic cells secreting insulin, glucagon, and somatostatin

Figure 2.27 Liver, Gallbladder, and Pancreas.



The relative locations and anatomy of the liver, gallbladder, and pancreas accessory organs are shown.





METABOLISM AND ENERGY BALANCE

LEARNING OBJECTIVES

- 1 | Explain human energy balance and the components of intake and expenditure.
- 2 | Understand human metabolism at the cellular level.
- 3 | Differentiate between aerobic and anaerobic energy systems in the body.
- 4 | Identify the body's energy currency and how it works within the energy system.

METABOLISM:

The process of converting ingested nutrients into energy in the body.

ENERGY:

The usable power derived from nutrient sources.

ENERGY BALANCE:

The symmetry between nutrient consumption and energy demands of the body.

CHEMICAL ENERGY:

The energy released as the bonds that hold chemicals together are broken.

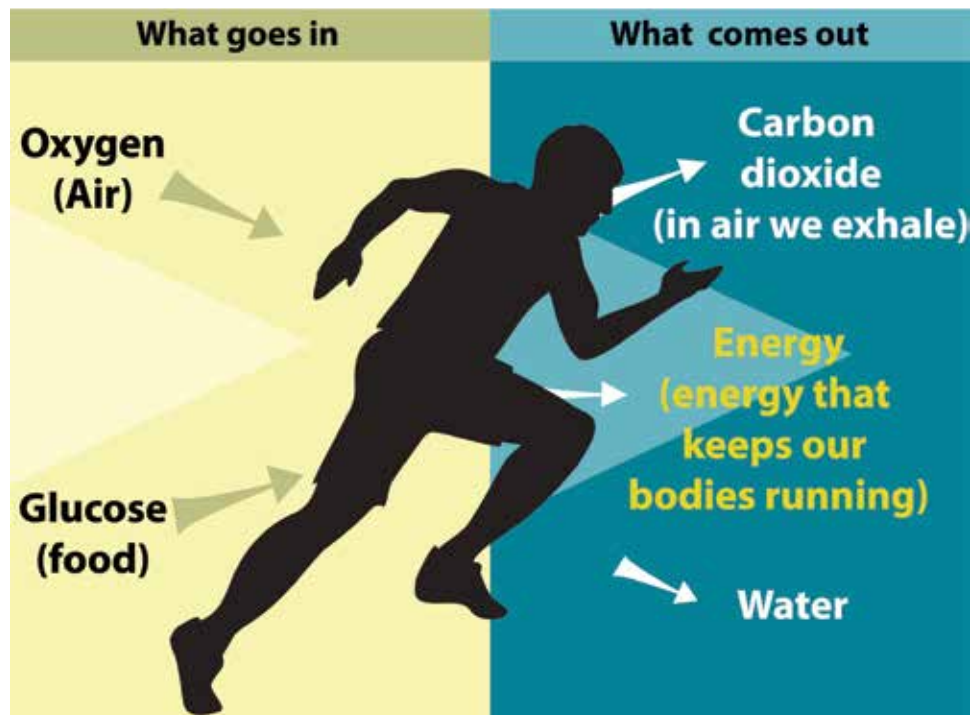
Metabolism is the way the human body converts consumed foods into a source of **energy** to power physiological processes. Energy requirements of the body for physical activity and bodily functions, such as digestion, respiration, and circulation, are met by the digestion and absorption of nutrients and the presence of oxygen. The balance between nutrient consumption and energy demands creates an **energy balance**.

DID YOU KNOW?

Did you know energy exists in six basic forms? These forms are chemical, nuclear, electrical, mechanical, thermal, and radiant. The form of energy humans and animals directly rely upon for survival is **chemical energy**.

The two important aspects of energy production and energy balance are nutrients and oxygen. Both are required to perform the cellular processes producing energy for body function.

Figure 3.1 How Energy Is Created.



NUTRITION AND ENERGY BALANCE

Metabolism is a detailed and complicated chemical process occurring within the cells of the body. When it comes to nutrition, understanding these processes, as well as energy balance, is important. In nutritional terms, energy is provided by a **calorie (cal)**. Technically written as a **kilocalorie (kcal)**, a calorie is the amount of energy needed to raise the temperature of 1 gram of water by 1°C (4.184 joules) at a pressure of 1 atmosphere.

Calories are provided by macronutrients, micronutrients, vitamins, and minerals consumed in the diet. The breakdown of these nutrient sources yields a specific number of calories individually.

CALORIE (CAL):

The amount of energy needed to raise the temperature of 1 gram of water by 1°C (4.184 joules) at a pressure of 1 atmosphere.

KILOCALORIE (KCAL):

Another name for a cal.

Table 3.1 Caloric Content of Macronutrients.

SOURCE	KCAL YIELD
Nutritional carbohydrate	4 kcal
Nutritional protein	4 kcal
Nutritional fat	9 kcal
Stored fat from carbohydrate source (adipose tissue)	3.27 kcal
Alcohol	7 kcal

ENERGY INTAKE

Total calorie intake in a 24-hour period, as compared to total energy expenditure in the same time, is used to measure energy balance. The simple observation for a fitness and nutrition professional is the gain or loss of body mass. If an individual gains weight over time, they are consuming an excess of calories compared to what they are expending. If an individual loses weight over time, they are consuming fewer calories than they are expending.

Excess calories lead to weight gain, while deficiency of calories leads to weight loss.

Research has shown the average American consumes about 3,600 calories a day, an increase of more than 24 percent from the average of 2,880 calories daily in 1961. The current guidelines from the US Department of Health and Human Services declare the average adult female requires 1,600–2,400 calories daily, and the average adult male requires 2,000–3,000 calories daily from all nutritional sources.

Table 3.2 Estimated Calorie Needs by Age, Gender, and Physical Activity Level.

AGE (YEARS)	MALES			FEMALES**		
	Sedentary*	Moderately active*	Active*	Sedentary*	Moderately active*	Active*
2	1,000	1,000	1,000	1,000	1,000	1,000
3	1,000	1,400	1,400	1,000	1,200	1,400
4	1,200	1,400	1,600	1,200	1,400	1,400
5	1,200	1,400	1,600	1,200	1,400	1,600
6	1,400	1,600	1,800	1,200	1,400	1,600
7	1,400	1,600	1,800	1,200	1,600	1,800
8	1,400	1,600	2,000	1,400	1,600	1,800
9	1,600	1,800	2,000	1,400	1,600	1,800
10	1,600	1,800	2,200	1,400	1,800	2,000
11	1,800	2,000	2,200	1,600	1,800	2,000
12	1,800	2,200	2,400	1,600	2,000	2,200
13	2,000	2,200	2,600	1,600	2,000	2,200
14	2,000	2,400	2,800	1,800	2,000	2,400
15	2,200	2,600	3,000	1,800	2,000	2,400
16	2,400	2,800	3,200	1,800	2,000	2,400
17	2,400	2,800	3,200	1,800	2,000	2,400
18	2,400	2,800	3,200	1,800	2,000	2,400
19–20	2,600	2,800	3,000	2,000	2,200	2,400
21–25	2,400	2,800	3,000	2,000	2,200	2,400
26–30	2,400	2,600	3,000	1,800	2,000	2,400
31–35	2,400	2,600	3,000	1,800	2,000	2,200
36–40	2,400	2,600	2,800	1,800	2,000	2,200
41–45	2,200	2,600	2,800	1,800	2,000	2,200
46–50	2,200	2,400	2,800	1,800	2,000	2,200
51–55	2,200	2,400	2,800	1,600	1,800	2,200
56–60	2,200	2,400	2,600	1,600	1,800	2,200
61–65	2,000	2,400	2,600	1,600	1,800	2,000
66–70	2,000	2,200	2,600	1,600	1,800	2,000
71–75	2,000	2,200	2,600	1,600	1,800	2,000
76+	2,000	2,200	2,400	1,600	1,800	2,000

*Sedentary, the activity of independent living; moderately active, independent living and the equivalent of walking 1.5–3 miles per day at 3–4 miles per hour; active, independent living and the equivalent of walking more than 3 miles daily at 3–4 miles per hour.

**Female estimates do not include pregnancy or breastfeeding.

Energy intake is measured by surveying food consumption over a 24-hour period. Typically, it is based on the individual's recall and is subject to the accuracy of reporting. Historical research has found the average human consumes about 3,500 kcal daily, but self-reporting showed average calorie consumption of 2,639 kcal daily for men and 1,793 kcal daily for women.

ENERGY EXPENDITURE

Energy expenditure is measured in a variety of ways. The classic method is a **calorimeter**, which measures heat production. **Direct calorimetry** uses an insulated chamber to measure heat added to the ambient environment, while **indirect calorimetry** measures oxygen consumed and carbon dioxide produced.

Energy expenditure is a result of the cumulation of four main processes in the body: **resting metabolic rate (RMR)**, **thermic effect of food (TEF)**, physical activity, and physical growth.

Resting Metabolic Rate

RMR is, specifically, the energy required to support cardiac function and respiration, repair internal organs, maintain body temperature, and balance water and ion concentrations across cell membranes. It is also referred to as basal metabolic rate (BMR). It consumes about two-thirds of the body's total energy expenditure in a 24-hour period and is the most influential of the physical processes consuming energy.

The RMR is correlated to body size and gender. Determining the exact RMR for an individual is nearly impossible. However, accurate formulas have been developed for health and fitness professionals to closely estimate the overall caloric needs for an individual. Predict an individual's BMR using the Harris-Benedict Formula:

$$\text{Men} = 66.4730 + (13.7516 \times \text{weight in kg}) + (5.0033 \times \text{height in cm}) - (6.7550 \times \text{age in years})$$

$$\text{Women} = 655.0955 + (9.5634 \times \text{weight in kg}) + (1.8496 \times \text{height in cm}) - (4.6756 \times \text{age in years})$$

Remember, resting metabolic rate (RMR) and basal metabolic rate (BMR) are synonymous

Thermic Effect of Food

The TEF accounts for the heat loss resulting from energy consumed when the body digests carbohydrate, fat, and protein. Also referred to as **diet-induced thermogenesis**, the thermic effect varies based on the macronutrient. For example, fats have a lesser thermic effect during digestion and absorption than protein and carbohydrates. The overall macronutrient composition of food consumed will also affect the TEF. Foods heavier in carbohydrates or protein will increase the body's heat production more than meals heavier in fats.

CALORIMETER:

A tool to measure heat production and energy expenditure.

DIRECT CALORIMETRY:

A way to measure energy expenditure in a chamber measuring ambient heat increases.

INDIRECT CALORIMETRY:

A way to measure energy expenditure by oxygen consumed and carbon dioxide produced.

RESTING METABOLIC RATE (RMR):

The energy expenditure of metabolic and physical processes when the body is at rest.

THERMIC EFFECT OF FOOD (TEF):

The energy expenditure associated with food consumption.

DID YOU KNOW:

Men tend to have higher RMR than women due to differences in body composition and, in older men, their higher levels of sympathetic nervous system activity?

DIET-INDUCED THERMOGENESIS:

The thermic effect of macronutrient digestion and absorption.

Physical Activity

Physical activity is second only to the RMR in terms of its effect on daily energy expenditure. Physical activity, including body movement, is directly related to an individual's body size, physical conditioning, and the amount (or distance) of movement performed. The more someone moves or exercises, the more energy they will expend. Energy expenditure from physical activity can be calculated using the heart rate as compared to resting heart rate data or through diaries of physical activity. Individuals with smart watches and activity trackers can estimate calorie burns from physical activity.

Figure 3.2 Physical Activity Trackers.



Growth

The body is constantly growing. Millions of cells die daily, and millions of cells are created to replace them. For babies, infants, and youth, their bodies are maturing and growing into their adult size at a rapid rate, meaning more cells are being created than are dying daily. The energetic cost of physical growth varies at different stages of life but is an important factor in total energy expenditure of the body.

The aspect of growth applies especially to pregnant women, who are not only supporting their own cell growth and turnover but also growing another human. The energy needs and expenditure of pregnant and lactating females is greater than the average but depends heavily on the stage of pregnancy or lactation.

ENERGY BALANCE

Creating an energy balance involves more than simple weight management. A **positive energy balance** means more energy is consumed than expended. A **negative energy balance** means more energy is expended than consumed. The body naturally seeks a homeostatic balance of the energy system, and this is evident in patterns of weight gain. Research shows individuals who gain body weight over time have periods of time when their weight plateaus, regardless of the positive energy balance.

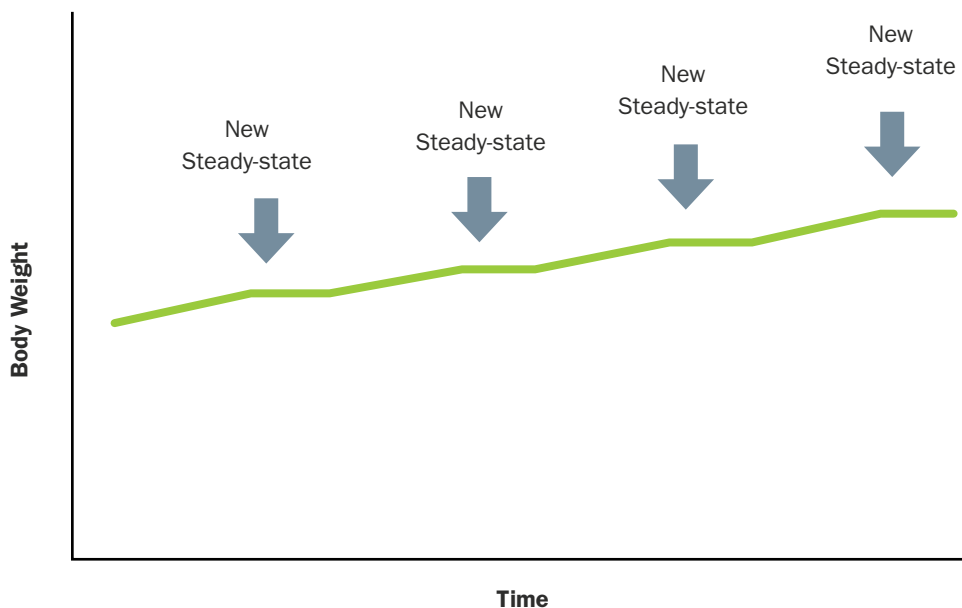
POSITIVE ENERGY BALANCE:

More energy is consumed than expended.

NEGATIVE ENERGY BALANCE:

More energy is expended than consumed.

Figure 3.3 Weight Gain and Energy Balance over Time.



Research has shown how relatively small adjustments in energy consumption and energy expenditure can slow the onset of weight gain and, ultimately, obesity. Simple changes such as a 200–300 kcal reduction in daily intake and incorporating 200–400 kcal of activity three or more times a week can make a difference in energy balance.

On a large scale, nutrition must be balanced—calories out versus calories in. On a cellular level, the way energy is produced is a complicated series of reactions that can be accelerated, decelerated, or limited based on the urgency of energy requirements.

CELLULAR ENERGY CURRENCY

Often referred to as cellular respiration, **cellular metabolism** is a series of reactions converting nutrients into the cellular energy currency **adenosine triphosphate (ATP)**.

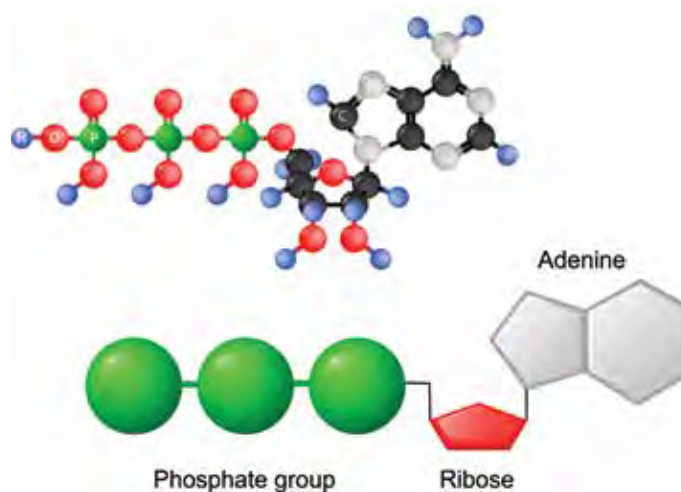
CELLULAR METABOLISM:

The series of reactions converting nutrients to ATP

ADENOSINE TRIPHOSPHATE (ATP):

The cellular energy molecule.

Figure 3.4 Adenosine Triphosphate.



Adenosine is made up of adenine and ribose. It is attached to three phosphates, and the two bonds between the three phosphates store and release energy.

The body contains all the raw materials needed to produce ATP. Food contains proteins, fats, and carbohydrates that can be broken down into ATP through a series of steps beyond mechanical and chemical digestion and absorption. The ATP is then broken down into smaller components to release energy and heat and then is recycled back to the original ATP structure, much like a puzzle that can be pieced together, taken apart, and then put together again.

This process follows the first law of thermodynamics, also known as the **law of conservation of energy**, which states that energy can be changed from one form to another but cannot be created or destroyed. Metabolism runs on **anabolic** and **catabolic** reactions, forming the cornerstone of human physiology.

CONVERTING ATP INTO ENERGY

ATP by itself does not provide cellular energy. The energy is stored within the bonds between the three phosphates in the ATP molecule, and those bonds need to be broken in the presence of water to release the energy.

ATP TO ADENOSINE DIPHOSPHATE PLUS ENERGY

The first step is to break down adenosine triphosphate into its simpler counterpart, adenosine diphosphate (ADP). That break requires an **enzyme**, which causes a chemical reaction to occur. In this case, the enzyme is **ATPase**, which breaks the bond between the second and third phosphates to release the stored energy. The phosphate-removal process, **dephosphorylation**, requires water (H₂O). This is one of the reasons why water makes up two-thirds of the body's weight. Importantly, the breakdown of ATP to ADP releases one acidic proton (H⁺).

LAW OF CONSERVATION OF ENERGY:

The principle stating energy cannot be created or destroyed but only changed from one form to another.

ANABOLIC:

The building process.

CATABOLIC:

The breakdown process..

ENZYME:

A protein catalyzing chemical reactions.

ATPASE:

An enzyme catalyzing the breakdown of ATP to ADP.

DEPHOSPHORYLATION:

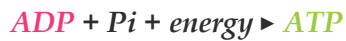
The process of removing a phosphate.

ATP-ADP CYCLE

The **ATP-ADP cycle** is the process allowing the cleaved ADP to be recycled back into the functional, energy-producing ATP within the cell. The process of reattaching phosphate (Pi), **rephosphorylation**, requires the enzyme **ATP synthase**. The molecule can then be broken down again for quick energy as part of the ATP-ADP cycle.



(dephosphorylation by the enzyme ATPase)



(rephosphorylation by the enzyme ATP synthase)

The breakdown of ATP to release its stored energy is called **ATP hydrolysis**. When ATP hydrolysis causes the muscle to accumulate protons (H⁺) faster than the muscle can remove them as waste, the result is metabolic acidosis. This impairs muscle power and energy production in the short term but may have the long-term effect of reprogramming the cell to recycle ADP faster and reduce the **oxidative stress** of the process.

ATP-ADP CYCLE:

A mechanism allowing ATP to be quickly broken into ADP and then re-formed.

REPHOSPHORYLATION:

The process of adding a phosphate.

ATP SYNTHASE:

An enzyme creating ATP

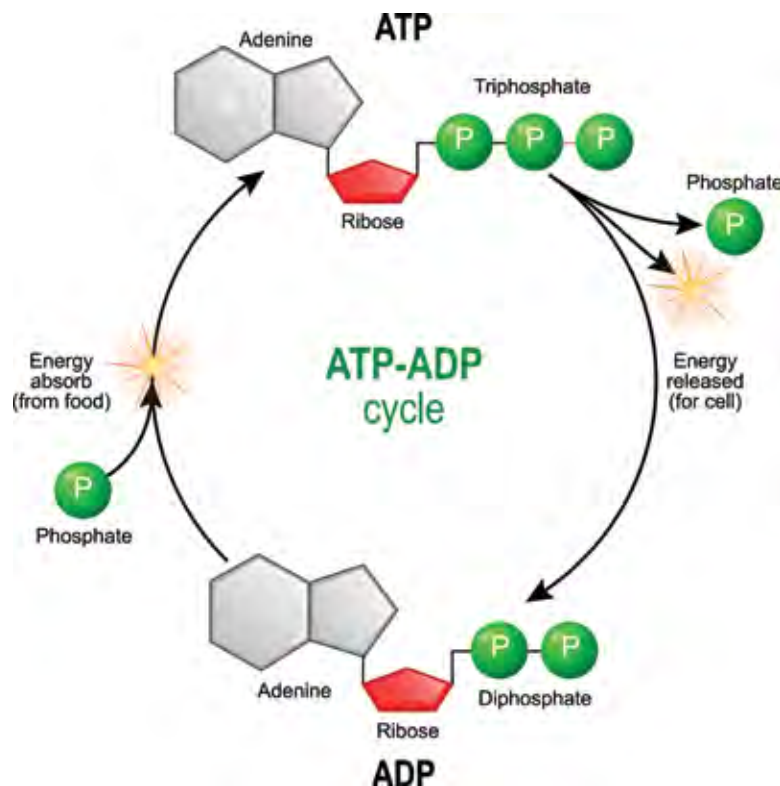
ATP HYDROLYSIS:

An enzyme creating ATP the breakdown of ATP while in the presence of water to release energy stored within its bonds.

OXIDATIVE STRESS:

The imbalance of reactive oxygen and the body's ability to detoxify or remove it.

Figure 3.5 Converting ATP into ADP and Back.



In the presence of water, the bond between the second and third phosphate ions of ATP is broken by the enzyme ATPase, which releases energy and one proton (H⁺). The enzyme ATP synthase reattaches the phosphate in the ATP-ADP cycle.

Muscles constantly generate protons during basic cellular metabolism, whether at rest or during activity. The body manages these hydrogen ions easily during rest or light activity by moving them into the mitochondria of the cells where their energy is harnessed to resynthesize ATP with the use of O₂ and formation of water. But as exercise intensity increases and more energy is required from ATP, many more protons are released, and avoiding acidosis (i.e., lower cellular pH) becomes a priority.

ADP TO ADENOSINE MONOPHOSPHATE

In the compound ADP, there are still two remaining phosphate ions, and the bond between them contains stored energy. In extreme circumstances, this bond can be used to generate needed cellular energy as well.

For an individual running at an all-out sprint lasting 10–15 seconds, at that intensity and duration the body has energy needs exceeding what the ATP-ADP cycle can provide. ADP accumulates in the muscle as it cannot rephosphorylate back into ATP fast enough. To meet immediate ATP demands, the enzyme **adenylate kinase** takes two ADP molecules and converts them into one ATP through rephosphorylation and one adenosine monophosphate (AMP) through dephosphorylation. This reaction can occur in both directions.

ADENYLATE KINASE:

An enzyme catalyzing the reaction between ATP and AMP to form two ADP molecules and vice versa.



However, when the cellular demand for energy remains high, ADP is unable to rephosphorylate back into ATP because it is not energetically favorable, meaning the cell cannot support the reaction efficiently at that moment. Instead, the ADP is dephosphorylated to AMP, a phosphate ion, and cellular energy. This reaction can occur in both directions.



AMP is not an ideal molecule to have in the cells. In extreme circumstances and with the addition of other enzymes, it can break down even further and create ammonia, which is toxic to the muscles and blood when produced in large quantities or unfiltered by the urinary system. The lone phosphate can also pose a problem since an accumulation of phosphates can cause muscle fatigue and limit physical performance.

THE ENERGY SYSTEMS

The body has three different energy systems, which can be classified as short-term, intermediate-term, and long-term energy systems. These systems overlap in virtually everything a human does. It is important to understand each system individually and when they are the most active and how nutrients contribute to their energy output.

OVERVIEW OF THE ENERGY SYSTEMS

Muscle tissues have enough stored ATP to last only a couple of seconds. To manufacture more ATP as quickly as possible, muscles turn to **phosphocreatine (PC)**. This process provides an instant source of energy—up to 30 seconds' worth. However, this source is quickly depleted. The muscle's stored ATP plus its phosphocreatine are collectively known as the **phosphagen system**.

As muscle tissue continues using phosphocreatine, **glycolysis**, in which ATP is made from **glucose**, emerges as the primary energy source. This occurs about seven seconds into the run. During glycolysis, a series of chemical reactions allow the body to break the glucose molecule into two **pyruvate** molecules, producing a small amount of ATP for a short amount of time—around two minutes. The process of glycolysis produces protons (H⁺). Once cellular acidity rises, muscle power declines. Research has shown that the end product of glycolysis is always lactic acid.

The phosphagen system and glycolysis are **anaerobic** processes, meaning neither requires the presence of oxygen.

The body begins with the pyruvate made through **anaerobic glycolysis**. With the addition of oxygen, it undergoes a complex series of steps to break down the pyruvate until it ends up in the mitochondria of the cell, where ATP is generated. This **aerobic metabolism** can now manufacture ATP for extended periods of time. Adipose tissue—stored fat—can also be used as a fuel source during aerobic metabolism.

The overview of the three energy systems suggests a relatively clear transition from one system to the next, but the transitions are not so definitive. These energy systems are always working in tandem in the body, but the immediate energy demand will determine which system is dominant.

PHOSPHOCREATINE (PC):

A molecule found in muscle and brain tissue donating its phosphate to ADP to form ATP.

PHOSPHAGEN SYSTEM:

The combination of a muscle's stored ATP plus its phosphocreatine.

GLYCOLYSIS:

The process of splitting a glucose molecule into a pair of pyruvate molecules.

GLUCOSE:

The smallest molecule a carbohydrate can be broken down into and used as an energy source.

PYRUVATE:

A three-carbon structure formed by splitting a glucose molecule.

ANAEROBIC:

A process that can occur without the help of oxygen.

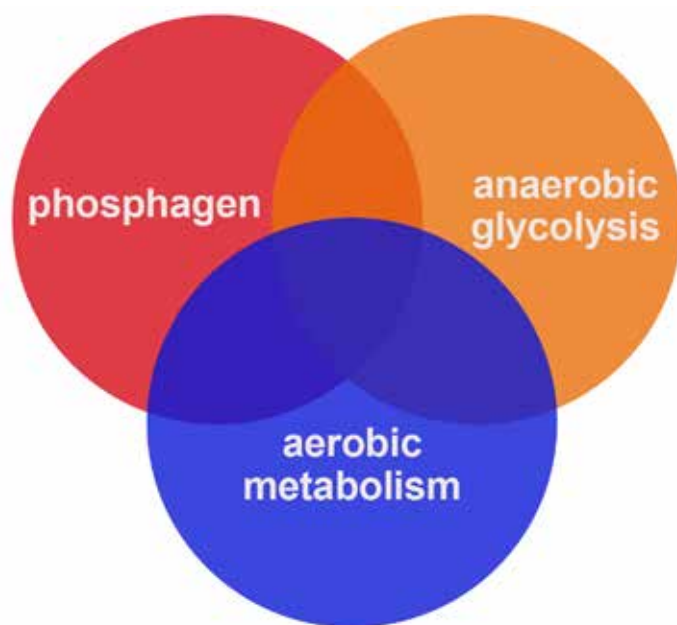
ANAEROBIC GLYCOLYSIS:

A the process of splitting a glucose molecule into a pair of pyruvate molecules to produce ATP when oxygen is low.

AEROBIC METABOLISM:

The breakdown of fuels to form ATP in the presence of oxygen.

Figure 3.6 Overlap of Energy Systems during Exercise.



The energy system most heavily recruited will depend on the immediate energy demand, but all three systems work in cooperation.

Energy Sources and Cellular Metabolism

KETONES:

By-product of fatty acid metabolism that can be used for energy.

There are four primary sources of energy: glucose, fatty acids, lactate, and **ketones**. Whether from dietary sources or supplements or naturally occurring in the body, ketones play one key role in cellular metabolism: producing ATP. The energy system primarily in use will determine which fuel source is the most efficient for energy production.

PHOSPHAGEN SYSTEM (ATP-PC SYSTEM)

Every cell within the human body contains cytoplasm, a semiliquid material. Like water inside an aquarium, cytoplasm surrounds and supports all the living material and organelles in the cell. The nucleus, which contains the deoxyribonucleic acid (DNA) used for growth, development, functioning, and reproduction, is the only part of the cell that is not considered part of the cytoplasm.

SARCOPLASM:

The cytoplasm of striated muscle fiber.

In muscle cells, cytoplasm is referred to as **sarcoplasm**. It serves the same purpose as the cytoplasm in a normal cell. The sarcoplasm of muscle cells is important, as it is where the actions of the phosphagen system and the reaction components take place. This process within muscle fibers puts ATP and released energy in a prime location to be used quickly for

muscle contraction.

Phosphocreatine includes one phosphate molecule connected to one molecule of **creatine**. Creatine is naturally found in muscle tissue, and maintaining average creatine stores will depend on overall muscle mass. For that reason, the ATP-PC system of energy production occurs only in muscle tissue, donating its phosphate to ADP to form ATP with the help of the **creatine kinase** enzyme.

All chemical reactions in the body require an enzyme to occur at a speed making them biologically viable. The enzyme serves as a lock, and the substrate—a substance like phosphocreatine—serves as the key. Every enzyme has binding sites for a substrate that are specific to that molecule. For example, glucose cannot bind at the site where phosphocreatine can bind and cause the same reaction. When the correct substrate binds to the enzyme, a reaction can occur, and a product can be created.

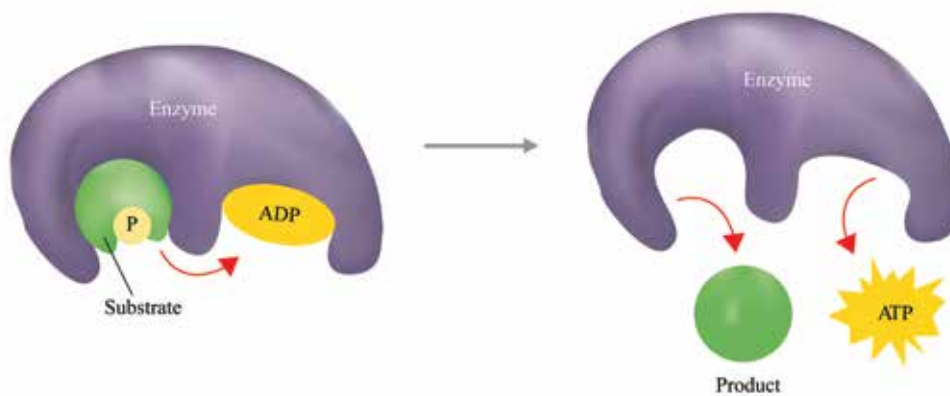
CREATINE:

A molecule synthesized in the liver and kidneys assisting reformation of ATP from ADP

CREATINE KINASE:

An enzyme catalyzing ADP to ATP and creatine to phosphocreatine.

Figure 3.7 Creatine Kinase Enzymatic Reaction.



The substrate (creatine) plus a phosphate binds to the enzyme (creatine kinase), which is also bound to a molecule of ADP. The phosphate is donated to the ADP when both are bound. The donation of the phosphate group to ADP immediately creates a molecule of ATP—and a single proton as a by-product of the phosphate-bond creation—which is released and stimulates the release of the lone creatine attached to the proton.

The creatine kinase reaction is critical for muscular contraction as it keeps the ATP-ADP cycle running. The more this cycle runs, the more protons will build up in the cytoplasm, reducing the pH of the muscle cell. The reduction of cellular pH is referred to as **metabolic acidosis**.

METABOLIC ACIDOSIS:

The reduction of cellular pH.

Replenishing Phosphocreatine

The phosphagen system is limited by the supply of phosphocreatine in the body. Naturally, creatine is synthesized in the kidney, pancreas, and liver from the amino acids methionine, glycine, and arginine. Creatine is stored in muscle tissue but also in the brain and has been identified as a major substrate in the immune response, the epithelial cells of the airway, and in neurotransmission. Once creatine reaches the inside of the muscle cells, it is bound to phosphate through rephosphorylation and becomes the active form of phosphocreatine needed for the ATP-ADP cycle.

GLYCOGEN:

The body's stored form of glucose.

Glucose is the muscle's next fastest source of ATP. **Glycogen** is the stored form of glucose in the body, and it is stored in the liver and skeletal muscle. When stored glycogen runs low, glucose in the bloodstream is forced into the muscle cells and broken down in a process called glycolysis (glyco means "glucose"; lysis means "breakdown"). Glycolysis can occur both in the presence of oxygen (aerobically) or without oxygen (anaerobically). In the presence of oxygen, the process is called oxidative phosphorylation. In the absence of oxygen, the process is called anaerobic glycolysis. Both processes produce many times more ATP than the phosphagen system.

ANAEROBIC GLYCOLYSIS

Unlike the phosphocreatine system, glycolysis occurs in the cytoplasm of nearly all cells in the human body, not just in muscle cells. During glycolysis, the glucose molecule is split into two pyruvate molecules. The split is regulated by the coenzyme **nicotinamide adenine dinucleotide (NAD⁺)**. NAD⁺ is found in all living cells and is essential for glycolysis. After going through glycolysis, it is converted to **NADH**. Importantly, glycolysis not only forms pyruvate and NADH but also releases an acidic proton, H⁺. The enzyme **lactate dehydrogenase (LDH)** is found in the walls of cellular mitochondria. This enzyme acts with pyruvate, NADH, and the excess proton (H⁺) to catalyze the release of the NADH proton and donate it to pyruvate, which forms lactate and NAD⁺. This secondary process is known as NAD⁺ regeneration, and the entire process is referred to as lactic acid fermentation.

NICOTINAMIDE ADENINE DINUCLEOTIDE (NAD⁺):

A coenzyme participating in glycolysis.

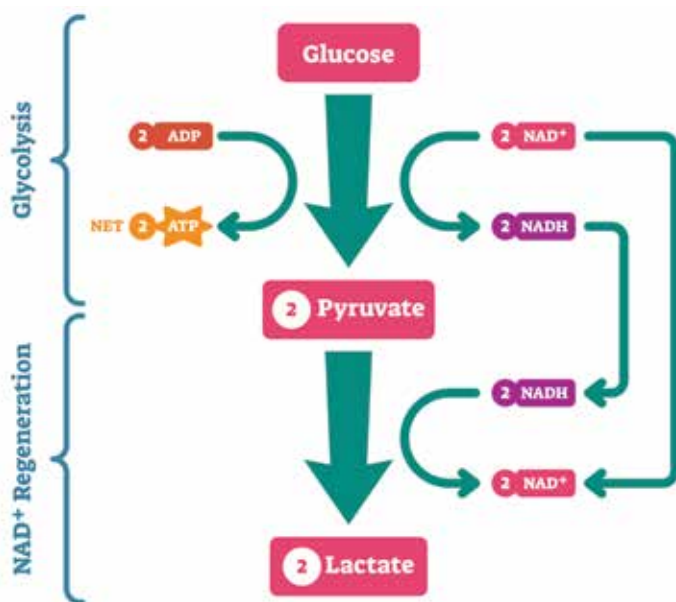
NADH:

The reduced form of NAD⁺ necessary for energy production.

LACTATE DEHYDROGENASE (LDH):

An enzyme catalyzing the conversion of pyruvate and NADH into lactate and NAD⁺, and vice versa.

Figure 3.8 Lactic Acid Fermentation.



The coenzyme NAD^+ and glucose create two pyruvate molecules and an excess proton and release two ATP molecules (energy) in the process. The pyruvate reacts with LDH and NADH to create lactate and NAD^+ , which can return to the beginning of the process and continue to break down glucose.

There are distinct differences in the ATP generation processes thus far. Glycolysis is acidifying to the muscle, unlike the phosphagen system, which is alkalinizing to the muscle. Protons are released in both glycolysis and ATP hydrolysis. In the first few seconds of maximal activity, the protons from ATP hydrolysis (phosphorylation) are buffered by the creatine kinase reaction. Anaerobic glycolysis has a similar buffer in place, but the buffer cannot consume all the newly released protons when lactate is formed and NADH is recycled back to NAD^+ .

AEROBIC METABOLISM

The **aerobic metabolism** produces ATP in the presence of oxygen. The process of aerobic metabolism begins with **acetyl coenzyme A (acetyl-CoA)** after the pyruvate molecule enters the mitochondria. This molecule must be formed no matter what source of fuel is used to make ATP. It is the “shuttle” triggering the first stage of aerobic metabolism, the **Krebs cycle**. The second stage is the **electron transport chain**, also called **oxidative phosphorylation**, which forms most of the ATP produced during aerobic metabolism. The outputs of aerobic metabolism are ATP, carbon dioxide (cellular waste expelled during respiration), and water.

AEROBIC METABOLISM:

A the breakdown of fuels to form ATP in the presence of oxygen.

ACETYL COENZYME A (ACETYL-COA):

The molecule entering the Krebs cycle to start aerobic metabolism.

KREBS CYCLE:

A series of chemical reactions within mitochondria to form ATP from the oxidation of acetyl-CoA.

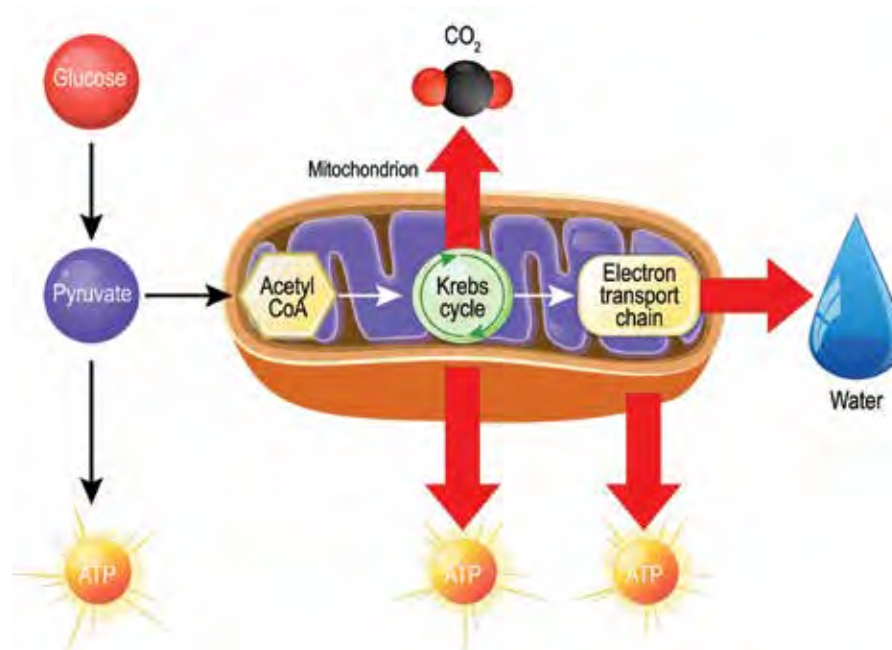
ELECTRON TRANSPORT CHAIN:

A metabolic pathway within mitochondria where most ATP molecules are formed during aerobic metabolism.

OXIDATIVE PHOSPHORYLATION:

Another name for the electron transport chain.

Figure 3.9 Aerobic Metabolism.



An overview of aerobic metabolism is shown. In the presence of oxygen, the initial pyruvate moves into the mitochondria, interacts with acetyl-CoA, enters the Krebs cycle, and moves through the electron transport chain.

Mitochondria

Mitochondria (singular is mitochondrion) are essential cell organelles generating most of the chemical energy needed for cellular processes. Some cells in the human body have more mitochondria than others (e.g., liver and muscle cells), and there are a few cell types lacking them altogether (e.g., red blood cells).

CRISTAE:

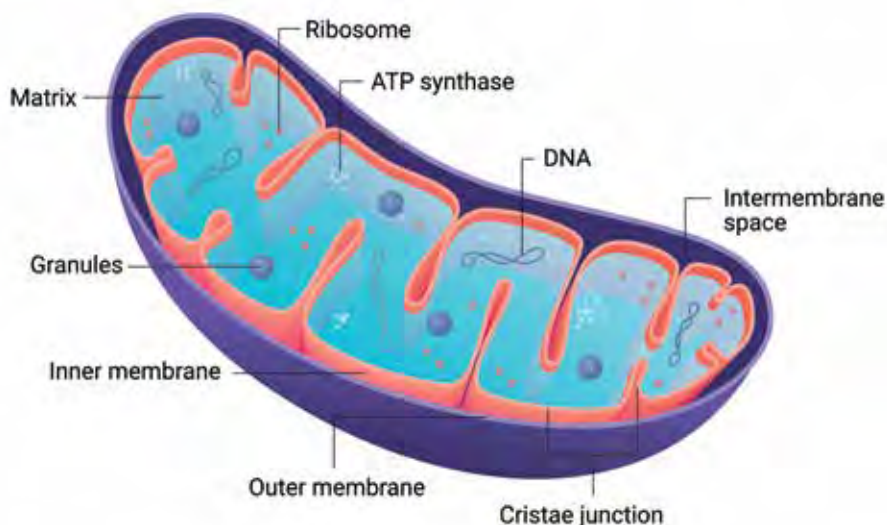
Folds of the inner membrane of a mitochondrion.

MATRIX:

Part of the mitochondria that is filled with enzymes, water, and proteins as well as the organelle's own unique DNA and ribosomes.

This specialized organelle has a dual membrane. The outer membrane of the organelle acts as a skin, while the inner membrane is folded—like the folds in the epithelial tissue of the intestines—many times over to increase the surface area. These folds are called **cristae**. The inner **matrix** of the mitochondria is filled with enzymes, water, and proteins as well as the organelle's own unique DNA and ribosomes. These organelles use their proteins, including pyruvate and acetyl-CoA, to break down oxygen and glucose—and other fuel sources—into energy, water, and carbon dioxide.

Figure 3.10 Mitochondrion Structure.



Aerobic metabolism can use four potential sources of fuel: glucose, fatty acids, lactate, and ketones. Each can be converted into acetyl-CoA, which can then enter the Krebs cycle, followed by the electron transport chain to complete aerobic metabolism.

Glucose for Fuel

Glycolysis splits glucose into a pair of pyruvates in the sarcoplasm of the muscle cell. With sufficient oxygen, pyruvate moves from the sarcoplasm into the mitochondria, where aerobic metabolism begins. Pyruvate is a three-carbon structure, and it must be converted into acetyl-CoA, which is a two-carbon structure.

Fatty Acids for Fuel

Fat is stored throughout the body in three different locations. Around the midsection, in the area between the abdominals and organs, is **visceral fat** (i.e., belly fat). Directly beneath the skin is **subcutaneous fat**, the most widely distributed fat in the body. And within the muscles are small amounts of **intramuscular fat**.

Fat is stored in all three locations as **triglycerides**. Before they can be used for energy, triglycerides are broken down into fatty acids through a process called **lipolysis**. Although it works differently, it is the equivalent of glycolysis, which breaks down glucose.

DID YOU KNOW:

when cellular energy needs are high, mitochondria can reproduce by growing in size and dividing? When they are not needed, they may die or become inactive in the cell.

VISCERAL FAT:

Fat stored around the midsection and major intra-abdominal organs.

SUBCUTANEOUS FAT:

Fat stored directly beneath the skin..

INTRAMUSCULAR FAT:

Fat stored within the muscles.

TRIGLYCERIDES:

The stored form of fatty acids.

LIPOLYSIS:

The breakdown of triglycerides into fatty acids.

Lactate for Fuel

Muscle tissue produces lactate during short-term contraction, even when there is sufficient oxygen. The lactate can then be used for energy through one of these two processes:

- **Remain in the muscle:** Lactate can stay inside the muscle, where it converts back to pyruvate. It then enters the mitochondria and produces ATP.
- **Move to other areas:** Some of the lactate will leave the sarcoplasm and go into the bloodstream. From there it can flow into another working muscle, including the heart. Or it can move to the liver, where it is converted to pyruvate, then to glucose, and then sent back through the bloodstream to wherever it is needed. If it is not needed, the glucose can be converted to glycogen and stored in the muscles or liver to fuel future activity.

GLUCAGON:

A hormone produced in the pancreas, increasing levels of glucose and fatty acids in blood.

KETOACIDOSIS:

A metabolic state where high levels of ketones are in the blood due to fatty acid metabolism.

Ketones for Fuel

Ketones are an acidic by-product of fatty acid metabolism, produced in the liver when glucose is not available. They are a normal part of human metabolism and usually well controlled by the hormones insulin and **glucagon**.

Trouble arises when starvation, a severe illness, infection, or a chronic disease such as diabetes forces the liver to metabolize large amounts of fatty acids. Supraphysiological blood ketone levels can cause metabolic acidosis and put stress on the kidneys. If ketones remain elevated too long, it can lead to **ketoacidosis**, a potentially fatal health problem.

Ketones will have an effect in extreme circumstances, including the following:

- A diet low in carbohydrates
- An ultralow-calorie diet
- An extreme physical endurance event

Ketones are also a significant source of ATP for the brain in those circumstances. After three days on a low-carbohydrate nutrition plan, for example, ketones provide as much as 30 percent of the brain's needs. After weeks without carbohydrates, ketones could supply up to 70 percent. The heart can also use ketones for energy.

When ketone levels are high during physical activity, they can easily travel from the blood into the muscle and then into the mitochondria, where they are converted to acetyl-CoA, enter the Krebs cycle, and produce ATP.

Acetyl-CoA

Regardless of the fuel source, acetyl-CoA is the central metabolite initiating the aerobic metabolism process within the mitochondria. In the initial step of the Krebs cycle, acetyl-CoA donates an acetyl group to a substrate called oxaloacetate to form the substrate citrate and two ATP molecules, thus entering the energy production cycle.

The Citric Acid Cycle

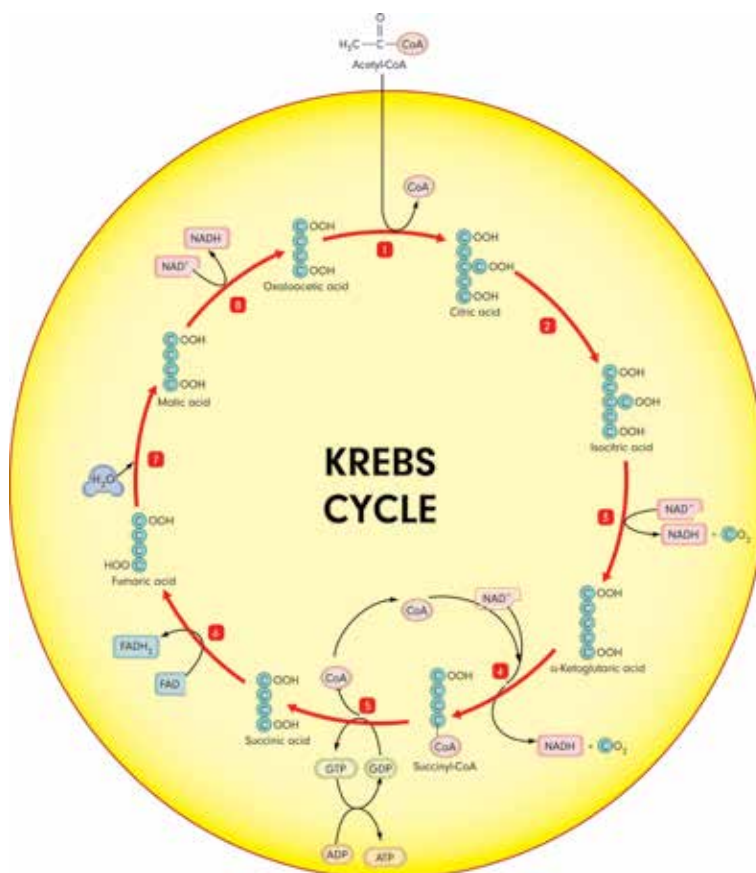
The Krebs cycle is also referred to as the citric acid cycle, named for one of its by-products. The cycle consists of eight consecutive steps in a closed loop, meaning the final step of the process re-creates the compound used in the initial step of the cycle.

The cycle is a series of hydration, dehydration, redox, and decarboxylation reactions, resulting in the formation of carbon dioxide, ATP, NADH, and **flavin adenine dinucleotide (FADH₂)**. NADH and FADH₂ are crucial products, as they are required to contribute electrons to the next step in aerobic metabolism.

FLAVIN ADENINE DINUCLEOTIDE (FADH₂):

A compound produced in the Krebs cycle supporting ATP formation.

Figure 3.11 The Krebs Cycle (Citric Acid Cycle).



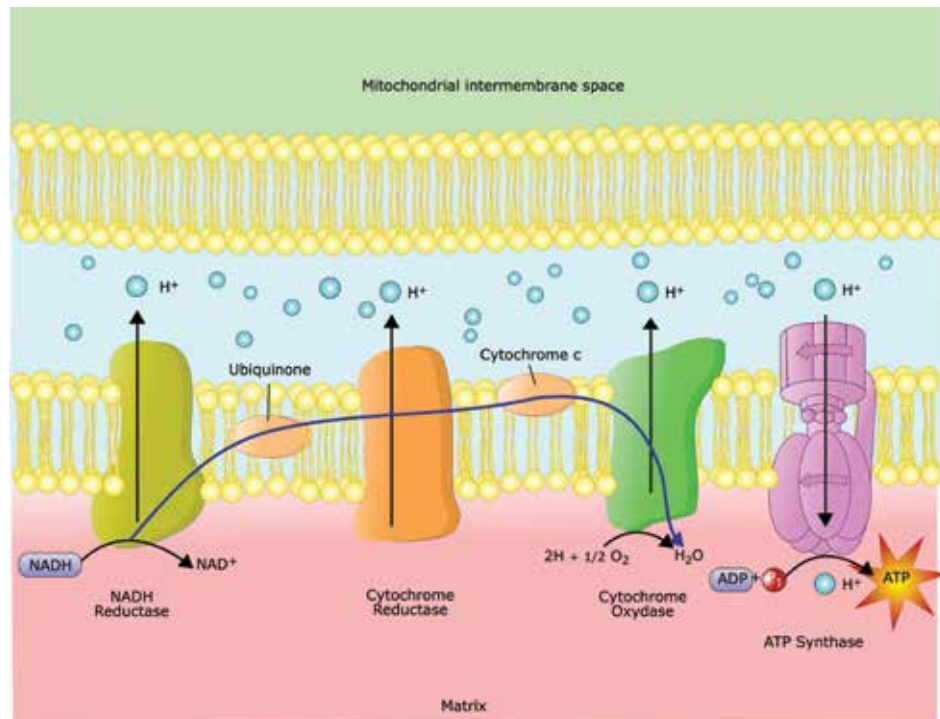
An overview of the energy-producing cycle is shown. It is a closed loop, meaning the initial compound is created by the final step of the cycle.

For the purposes of this course, the details of the reactions occurring at each step in the citric acid cycle are unnecessary. However, the results of the cycle feed into the next step of ATP production. Each citric acid cycle produces one ATP molecule, three NADH molecules, one FADH₂ molecule, two carbon dioxide molecules, and three protons (H⁺).

The Electron Transport Chain

This is the stage where most of the ATP is produced in aerobic metabolism—32 ATP molecules, in fact. The electron transport chain uses the FADH₂ and NADH from the citric acid cycle to release electrons through a series of three intermembrane transporters. In the process, protons (H⁺) are moved into the intermembrane space, and oxygen is reduced to produce water as a by-product. The final intermembrane transporter is ATP synthase. This enzyme moves the protons back into the mitochondrial matrix from the intermembrane space and, in the process, phosphorylates one ADP into one ATP molecule for each proton transported across the membrane.

Figure 3.12 The Electron Transport Chain and ATP Synthase.



NADH and FADH₂ contribute electrons to the three intermembrane transporters (olive, orange, and green). The resulting protons (H⁺) are pulled back into the cell via ATP synthase (purple) to drive the phosphorylation of ADP and produce ATP.

The various sources of fuel for aerobic metabolism will ultimately determine how much ATP can be produced. Glucose, fatty acids, lactate, and ketones each supply a different number of carbon molecules to the initial carbon donation to the citric acid cycle.

Table 3.3 ATP Production from Various Fuel Sources.

FUEL TYPE	MOLECULE DONATING	NUMBER OF CARBONS DONATED	ATP PRODUCTION
Glucose	2 pyruvate	6 (3 for each pyruvate)	30–32 ATP
Fatty acids	1 palmitic acid	16	106 ATP
Lactate	Lactate	6	30–32 ATP
Ketones	Amino acids	2	22 ATP

The use of different initial fuel sources will dictate how much ATP will be produced. Fats are the most effective at producing ATP.





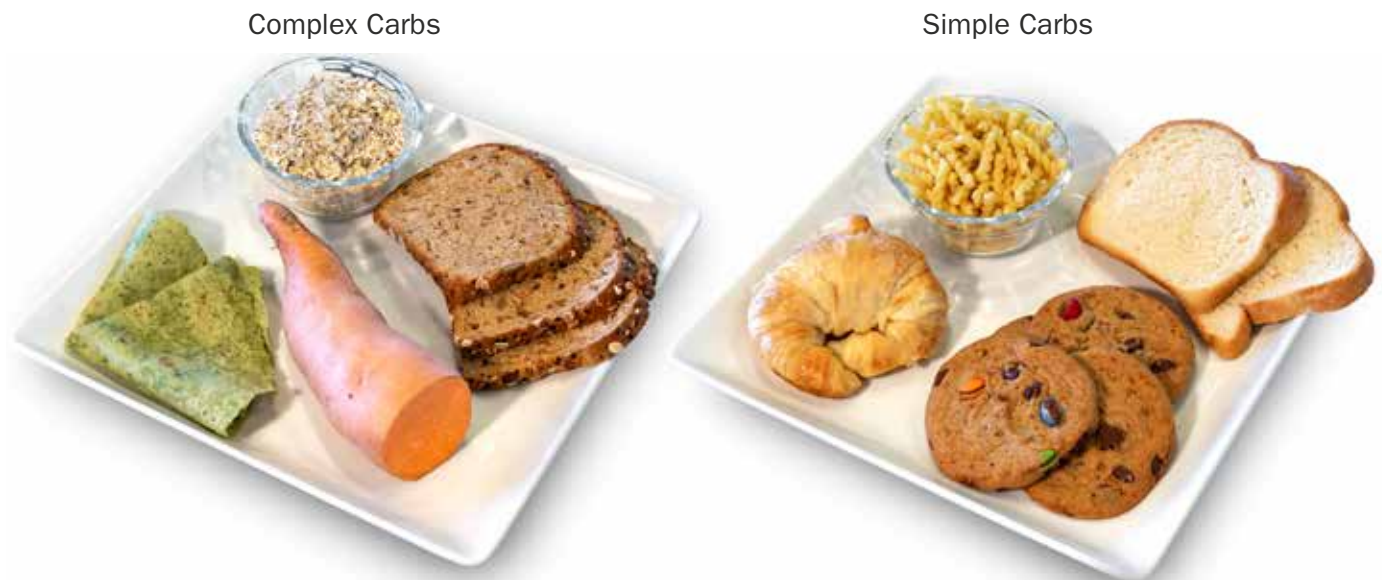
CARBOHYDRATES

LEARNING OBJECTIVES

- 1 | Identify and describe the different types of carbohydrates
- 2 | Explain the importance of fiber
- 3 | Explain how glucose is stored and used for energy
- 4 | Describe how the human body digests carbohydrates

Carbohydrates are a macronutrient that may be just as confusing as fats are for most individuals. There are several types of carbohydrates classified by their digestion process and they provide a large energy source for the human body. However, too much of anything can prove harmful, so a balance must be established with the other macronutrients for a balanced and healthy diet.

Figure 4.1 Types of Carbohydrates



CARBOHYDRATES

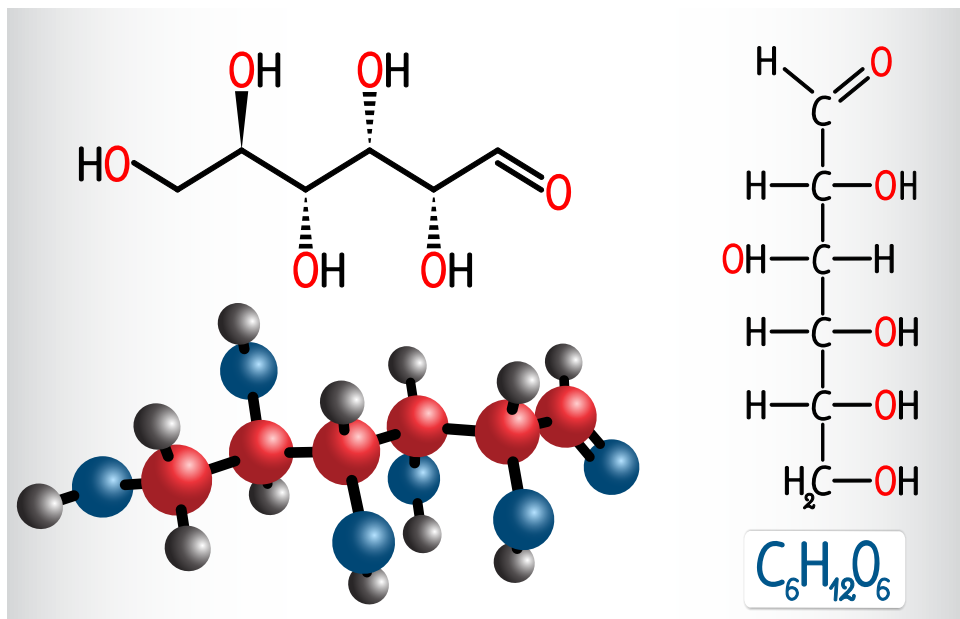
Carbohydrates are organic molecules that are used primarily for energy. In fact, they are the main source of energy for the human body. Often referred to as carbs, they protect muscle mass (protein) from being catabolized during exercise and they provide the main energy source for the brain and nervous system when it is broken down into **glucose** during digestion.

GLUCOSE:

A simple sugar made of 6 carbon, 12 hydrogen, and 6 oxygen that provides energy in the body.

Glucose is a simple sugar consisting of 6 carbons, 12 hydrogens, and 6 oxygens. One molecule of glucose produces about 30 molecules of adenosine triphosphate (ATP) via glycolysis during cellular metabolism.

Figure 4.2 The Structure of Glucose



There are several types of dietary carbohydrates that provide energy—for instance, simple carbohydrates, or sugars, and complex carbohydrates, or **starch**.

The different types of carbohydrates are based on the number of sugar units and chemical structure. Some of the scientific classification categories include **monosaccharides**, **disaccharides**, **oligosaccharides**, and **polysaccharides**.

SIMPLE CARBOHYDRATES

There are two types of **simple carbohydrates** :

- **Monosaccharides**. Monosaccharide carbohydrates consist of one sugar unit. They are the simplest form of sugar that make up more complex carbohydrate molecules. Examples include glucose (also referred to as dextrose), galactose, mannose, and **fructose**.
- **Disaccharides**. Disaccharides consist of two sugar units. Examples include sucrose, which is made of one molecule each of glucose and fructose; maltose, made of two molecules of glucose; and lactose, made of one molecule each of glucose and galactose.

STARCH:

The energy source of plants; a polysaccharide consisting of multiple molecules of bonded glucose.

MONOSACCHARIDES:

Carbohydrates consisting of one sugar unit.

DISACCHARIDES:

Carbohydrates consisting of two sugar units.

OLIGOSACCHARIDES:

Carbohydrates with 3 to 10 sub-units of sugar.

POLYSACCHARIDES:

Complex carbohydrates that have 10 or more monosaccharide sub-units linked together.

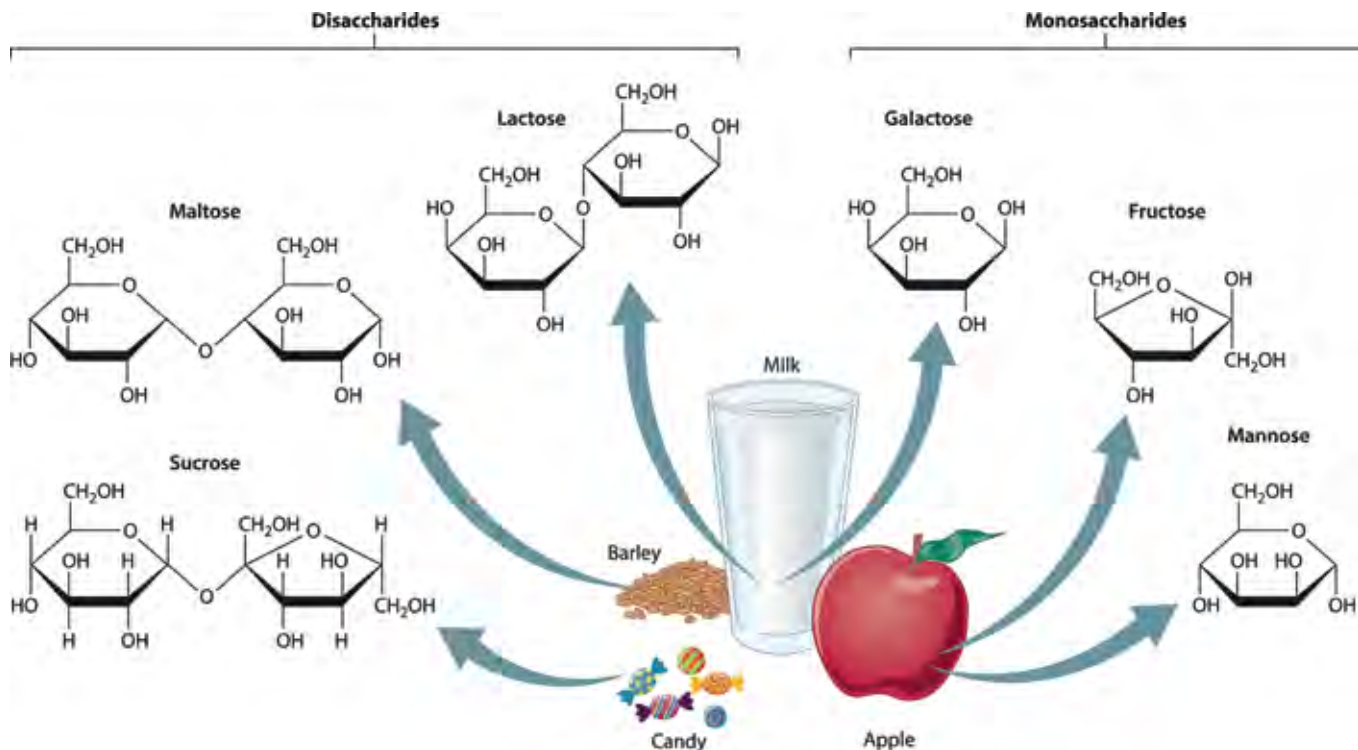
SIMPLE CARBOHYDRATE:

Sugars, made of just one or two monosaccharides, digested quickly in the body as a fast energy source.

FRUCTOSE:

A simple sugar found mostly in fruits.

Figure 4.3 Disaccharides and Monosaccharides



Sugar is a catchall term that refers to different types of simple carbohydrates. For example, table sugar is sucrose. Blood sugar refers to the glucose present in the blood. Blood sugar level is influenced by the types of carbohydrates consumed.

The principal monosaccharides in food are glucose and fructose. Glucose is found commonly in fruit, sweet corn, corn syrup, certain roots, and honey. It is also a subunit of some complex carbohydrates, like starch.

FRUCTAN:

A polymer of fructose molecules found in some fruits, legumes, and vegetables.

Fructose, which is also called levulose or fruit sugar, is found as free monosaccharides in fruits and other foods. It is also a sub-unit of the sucrose molecule, found in fruit and table sugar, and is a component of the carbohydrates known as **fructan**.

Although both fructose and glucose are common simple sugars in the diet, they function differently as energy sources. Glucose is used more quickly and efficiently by muscles, while fructose is used more slowly.

DID YOU KNOW:

Glucose is one of the most commonly encountered sugars in the diet. Fructose became more popular with the discovery that it does not trigger changes in blood sugar as rapidly as glucose.

Researchers realized this in the early 1980s when they undertook the first extensive comparisons of the different carbohydrates and carbohydrate-containing foods. Fructose must be converted to glucose in the liver before being used by most cells in the body which explains the slower rise in blood sugar after eating fructose.

COMPLEX CARBOHYDRATES

There are two main types of complex carbohydrates:

- **Oligosaccharides**. Complex carbohydrates with 3 to 10 sub-units of sugar are oligosaccharides. Some examples include raffinose and stachyose.
- **Polysaccharides**. Polysaccharides are complex carbohydrates that have 10 or more monosaccharide sub-units linked together. Starch, composed of amylose and amylopectin, is a main dietary complex carb. Both amylose and amylopectin are made of units of glucose. **Glycogen** is another polysaccharide that is used to store carbohydrate energy in the body.

Regardless of the form in which glucose and other carbs are ingested, each gram of carbohydrate provides approximately four kilocalories of energy. The biggest difference between types of carbs consumed is in how they are digested and used. The more complex the bonds between the units of different sugar types, the slower the digestion and absorption. Each type of carb requires different enzymes and reactions to break them down and be metabolized.

FIBER

Fiber is a special type of complex carbohydrate not digested and not absorbed in the small intestine. Fiber is sometimes called roughage or non-starchy polysaccharides.

Some examples of fiber include cellulose, hemicellulose, pectin, fructans, beta-glucans, and a variety of gums, mucilage, and algal polysaccharides. Fibers are usually components of plant cell walls and intracellular structures. Although largely indigestible, fiber plays an important role in the diet. Fiber helps promote efficient intestinal functioning and aids in the absorption of sugars and other nutrients into the bloodstream.

GLYCOGEN:

A complex carbohydrate that occurs only in animals; the form in which glucose is stored in the body.

There are two types of dietary fiber, and most plant foods contain some of each kind:

- **Soluble fiber.** Soluble fiber dissolves in fluids in the stomach to form a thick gel-like substance. It is broken down by bacteria in the large intestine and provides some calories, about two kilocalories per gram. Soluble fiber can interfere with the absorption of dietary fat and cholesterol. This, in turn, can help lower low-density lipoprotein (LDL) cholesterol levels in the blood. It also slows digestion and the rate at which carbohydrates and other nutrients are absorbed into the bloodstream which prevents rapid spikes in blood glucose after eating.
- **Insoluble fiber.** Insoluble fiber does not dissolve in water and passes through the gastrointestinal tract relatively intact and is not a source of calories. Insoluble fiber provides bulk for stool formation and speeds up the movement of food and waste through the digestive system.

Fiber is usually found along with digestible simple and complex carbohydrates in various plant foods, such as fruits, leaves, stalks, and the outer coverings of grains, nuts, seeds, and legumes. Dietary fiber helps soften the stool and encourages normal elimination. Fiber-rich diets, both soluble and insoluble, also promote satiety. In addition, research has shown that people who eat high-fiber diets experience reduced rates of cardiovascular disease, colon cancer, and diabetes. It is important to include plenty of fluids in a high-fiber diet to move them through the digestive tract.

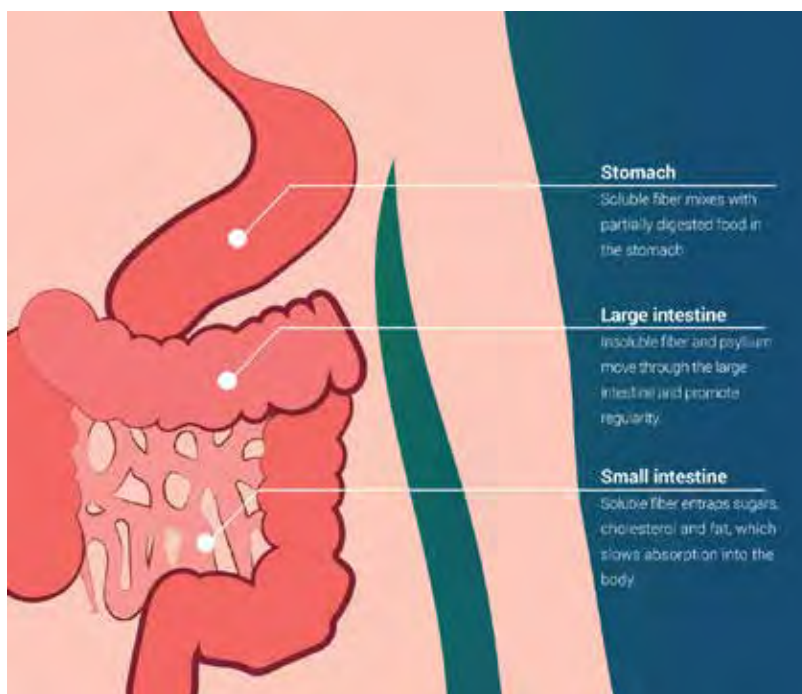


DID YOU KNOW:

Both fiber and digestible carbohydrates contribute to helpful gut bacteria. The **gut microbiome** depends on nourishment just like any other ecosystem. Prebiotic and probiotic supplements and foods provide nutrition to support friendly, so-called good bacteria in the gut, which can aid in digestive health and proper functioning. Research suggests that gut bacteria particularly prefer fructans and cellulose.

GUT MICROBIOME:

The specific and individualized accumulation of anaerobic bacteria and other microorganisms that populate the gastrointestinal tract.



THE ROLE OF GLYCOGEN IN THE BODY

Glycogen is the main storage unit of glucose that the body uses for energy. It is like the starch that is found in plants in that it consists of chains of glucose units. However, glycogen and starch differ in structure. Due to the human body's limited storage capacity for glycogen, a relatively constant supply of carbohydrates is needed throughout the day.

The body converts a portion of all ingested complex carbohydrates into glycogen, replenishing its short supply. Depending on individual factors, the total glycogen supply in the body is limited to 1,800 to 2,600 calories. The body constantly stores and releases glucose to and from glycogen. Whether glucose is released or stored depends on food ingested, time between eating, and shifting energy demands related to physical activity.

Glycogen is stored in all cells, but it is mostly found in liver and muscle cells. They serve as reservoirs for glucose. The liver's glycogen supply is used to regulate the blood sugar level and is the main source of energy for the brain. The brain can use more than 400 calories of glucose per day from the liver's glycogen store.

Each ounce of glycogen is stored in the liver with about three ounces of water. This means that when glycogen is used, water is also removed from the body. Many fad diets take advantage of this phenomenon by limiting carbs and increasing protein consumption, which causes liver and muscle glycogen to become quickly depleted. This results in a loss of several pounds of water, which many dieters mistake for a loss of bodyfat. However, research suggests that fasting can impact glycogen levels and encourage the body to use adipose tissue as an energy source.

Physically active individuals sometimes have a feeling of being bogged down or mentally sluggish. This is often due to a low level of liver glycogen. Eating an adequate amount of complex carbohydrates, especially at night, replenishes the glycogen supply and restores mental alertness and physical energy.

CARBOHYDRATE DIGESTION

Carbohydrates take different amounts of time to break down depending on type. Thorough and complete chewing of food is the first step in digestion and is important to making the process quicker and more efficient.

FROM MOUTH TO STOMACH

MASTICATION:

Chewing.

BOLUS:

A mass of chewed food.

AMYLASE:

An enzyme found largely in saliva that breaks starch into simpler sugars.

Digestion begins in the mouth with the act of chewing, or **mastication**. Chewing breaks down food mechanically by grinding it into smaller units. Saliva lubricates the **bolus** to help it travel down the esophagus. Chemical digestion of carbohydrates begins when an enzyme in the saliva starts breaking down carbohydrate chains.

This enzyme is called **amylase**. It breaks the bonds that hold together disaccharides, oligosaccharides, and starches. Amylase also breaks down amylose and amylopectin into shorter chains of glucose—called dextrins—and maltose. Maltose is a disaccharide that makes starches taste sweet.

Only about 5 percent of starches are broken down in the mouth. The mechanical breakdown continues in the stomach and prevents the presence of excess glucose in the mouth that can lead to dental caries. The contraction and relaxation of the stomach mixes carbohydrates into a substance called chyme.

FROM STOMACH TO SMALL INTESTINE

Once the chyme enters the small intestine, the pancreas releases pancreatic juice. This includes pancreatic amylase, which helps to break the dextrins into shorter chains. Enzymes excreted from the **villi** in the intestinal walls—lactase, maltase, and sucrase—break down specific molecules.

- Lactase breaks lactose into galactose and glucose.
- Maltase breaks the bond between two units of maltose.
- Sucrase breaks sucrose into glucose and fructose.

Once these carbohydrate chains have been broken down into simple sugar units, they are transported into the intestinal cells called enterocytes.

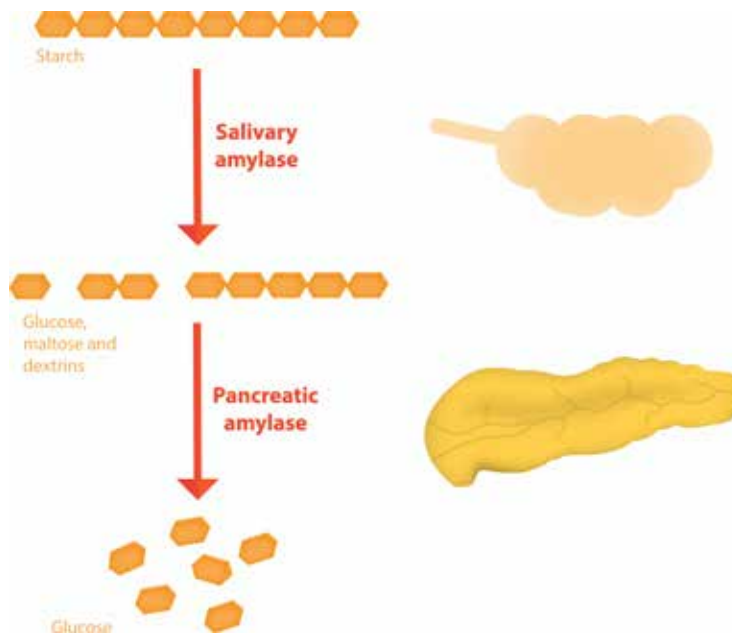
VILLI:

Fingerlike projections on the inside surface of the intestines that absorb nutrients and secrete enzymes.

DID YOU KNOW:

Lactose intolerance results from insufficient lactase production. Undigested lactose makes its way to the large intestine, where bacteria break it down. This process creates gas, diarrhea, bloating, and abdominal cramps.

Figure 4.4 The Breakdown of Starch to Glucose



From the mouth with salivary amylase, the breakdown continues in the small intestine with pancreatic amylase.

ABSORPTION INTO BLOODSTREAM

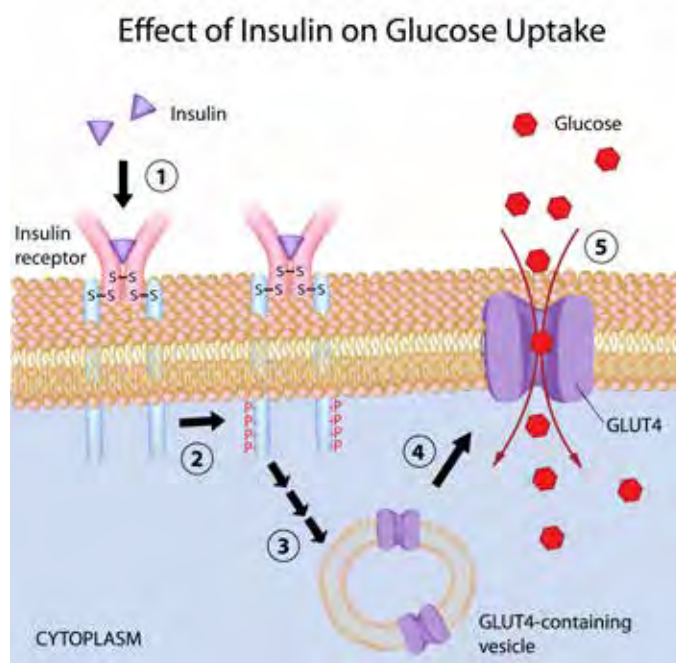
Monosaccharides enter the bloodstream with the help of transport proteins. There are 12 glucose transporters named GLUT 1 through 12. All facilitate the diffusion of sugars into the bloodstream.

INSULIN:

A hormone made by the pancreas that helps move glucose from the blood to muscle and other tissues.

DID YOU KNOW:

Though GLUT4 transporters are always found in cells to some degree, the binding of **insulin** to its receptor increases the transporter activity in a cell's membrane. Exercise has been shown to have the same effect, resulting in more control over blood sugar levels without the use of insulin. This is one reason an active lifestyle can help prevent the insulin tolerance associated with type 2 diabetes.



1. Insulin binds to the cell membrane insulin receptor
2. The receptor is polarized by the phosphorylation of ATP (energy)
3. Polarization activates the GLUT4 vesicle
4. The vesicle stimulates glucose transport with the GLUT4 membrane transport protein

Monosaccharides are transported to the liver by the portal vein. The liver is the first destination for fructose, galactose, and glucose. In the liver

- galactose is converted to glucose,
- fructose is broken down, and
- glucose is stored as glycogen.

The pancreas and liver regulate blood glucose levels. Glucose also self-regulates through a negative feedback loop similar to a thermostat in the home. A specific temperature is set, and when the home reaches that temperature, the thermostat shuts off the system. The glucose thermostat is in the pancreas.

After eating carbohydrates, blood glucose levels rise. Generally, blood glucose levels begin to rise 10 to 15 minutes after a meal. After about 60 minutes, they reach their peak. However, the extent and speed of the rise depend on many factors.

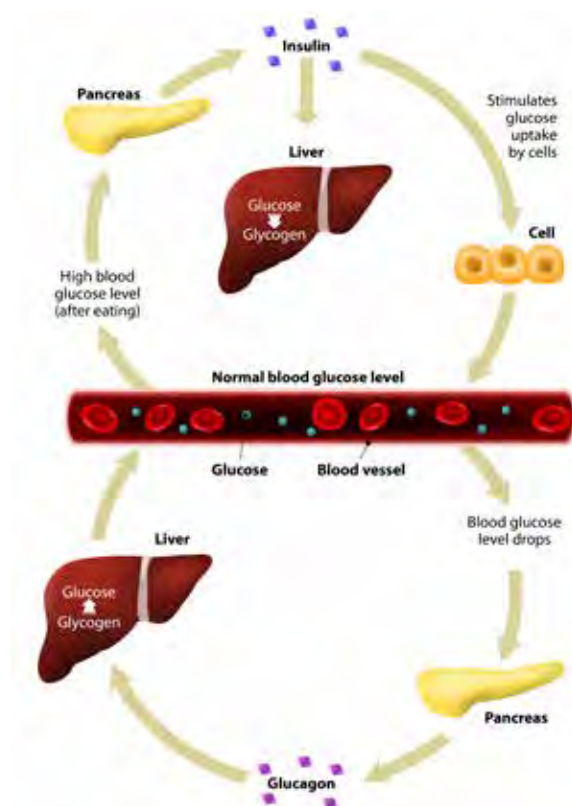
When blood glucose levels increase, insulin-secreting cells in the pancreas release insulin into the blood. Insulin acts as a messenger, telling the body's cells to absorb glucose from the blood. Cells take up the glucose and use it for energy production via glycolysis.

At some point after eating, blood glucose levels decrease. **Glucagon** secreting cells in the pancreas sense the decreased concentration and release glucagon into the bloodstream. Glucagon is the messenger hormone that tells the cells to stop using glucose and to release stored glucose back into the blood.

GLUCAGON:

A pancreatic hormone that raises glucose levels in the blood.

Figure 4.5 Insulin and Glucagon



DID YOU KNOW:

Preventing **hypoglycemia**, or low blood sugar, is possible with the aid of cortisol, growth hormone, and glucagon. They ensure glucose is always available for the brain and work to prevent low blood sugar. These hormones are both inhibited and stimulated by the fluctuation of other hormones.

HYPOGLYCEMIA:

A state of low blood sugar levels with many causes, including diabetes treatments.

GLYCEMIC INDEX (GI):

A ranking of carbohydrate-based foods on a scale from 0 to 100 according to the extent to which they raise blood sugar levels after eating.

GHRELIN:

A hormone released from the stomach that stimulates appetite.

LEPTIN:

A hormone made from adipose tissue and the enterocytes of the small intestines that regulate energy balance and inhibit hunger.

GLYCEMIC INDEX

The **glycemic index (GI)** is a ranking of carbohydrate-based foods on a scale from 0 to 100 according to the extent to which they raise blood sugar levels after eating. This is measured and ranked compared to a reference food, usually glucose with a GI of 100 and proteins and fats are not scored on this index.

Foods with a high GI are rapidly digested, absorbed, and metabolized, leading to large fluctuations in blood sugar. A diet with too many high-GI foods may lead to overconsumption and weight gain. High-GI foods increase insulin levels quickly which creates a higher physiological response resulting in hypoglycemia shortly after a meal⁸. This, in turn, will signal the hormonal response to indicate hunger.

Eating low-GI foods results in smaller, slower changes in blood sugar levels and therefore lower insulin levels. This helps maintain fullness longer and prevents overeating since the hunger hormones **ghrelin** and **leptin** are controlled. Research has shown that diets rich in low-GI foods increase weight loss and reduce the risk for developing obesity, type 2 diabetes, and cardiovascular disease.

The GI of a food depends on several factors:

- **Type of sugar.** Glucose has a value of 100, sucrose has a value of 65, and fructose has a value of 19.
- **Starch structure.** Amylose and amylopectin molecules make up starch. Foods high in amylose are more difficult to digest and therefore have a lower GI.
- **Processing.** Processed foods generally have a higher GI value than whole foods.
- **Preparation.** The longer a food, like pasta, is cooked, the higher the GI.
- **Ripeness.** The complex carbohydrates in fruit break down into simple carbohydrates as the fruit ripens. For example, an unripe banana has a GI of 30, and an overripe banana has a GI of 48.

There are some limitations to using the GI to score foods:

- The index does not account for how portion size affects GI value.
- Combining foods changes the GI for the overall meal. For example, beans and rice together will have a different GI effect than the rice alone.
- Proteins and fats do not have GI scores. Adding these macronutrients to a GI food may change the digestion timing and, thus, the GI score.

The GI of a food is typically considered to be low, medium, or high according to the following ranges:

Low GI: 1 to 55 **Medium GI: 56 to 69** **High GI: 70 and above**

Table 4.1 Glycemic Index of Foods

LOW GLYCEMIC FOODS LIST 0 - 55	MEDIUM GLYCEMIC FOODS LIST 56 - 69	HIGH GLYCEMIC FOODS LIST 70+
Most non starchy vegetable < 15 Peanuts < 15 Low-fat yogurt, no sugar < 15 Tomatoes 15 Cherries 22 Peas 22 Plum 24 Grapefruit 25 Pearled barley 25 Peach 28 Can peaches, natural juice 30 Soy milk 30 Baby lima beans 32 Fat-free milk 32 Low-fat yogurt, with sugar 33 Apple 36 Pear 36 Whole weat spaghetti 37 Tomato soup 38 Carrots, cooked 39 Apple juice 41 All-Bran 42 Canned chickpeas 42 Custard 43 Grapes 43 Orange 43 Canned lentil soup 44 Macaroni 45 Pineapple juice 46 Banana bread 47 Long-grain rice 47 Bulgur 48 Canned baked beans 48 Grapefruit juice 48 Green peas 48 Oat bran bread 48 Old-fashioned porridge 49	Canned kidney beans 52 Kiwifruit 52 Orange juice 52 Banana 53 Potatoe chips 54 Special K 54 Sweet potato 54 Brown Rice 54 Linguine 55 Oatmeal cookies 55 Popcorn 55 Sweet corn 55 Muesli 5 White rice 56 Pita bread 57 Blueberry muffin 59 Bran muffin 60 Hamburger bun 61 Ice cream 61 Canned apricots, light syrup 64 Macaroni and cheese 64 Raisins 64 Couscous 65 Quick-cooking porridge 65 Rye crisp-bread 65 Table sugar (souce) 65 Instant porridge 66 Pineapple 66 Taco shells 68 Whole wheat bread 68	Bagel 72 Corn chips 72 Watermelon 72 Honey 73 Mashed potatoes 73 Cheerios 74 Puffed wheat 74 Doughnuts 75 French fries 76 Vanilla wafers 77 White bread 79 Jelly beans 80 Pretzels 81 Rice cakes 82 Mashed potatoes, instant 83 Cornflakes 84 Baked potato 85 Rice, instant 91 French bread 95 Parsnips 97 Dates 100

GLYCEMIC LOAD

The GI of a food provides an estimate of how a food raises blood sugar levels but does not consider portions or quantity.

The glycemic load (GL) is a calculation that considers both GI value (carbohydrate quality) and portion size (carbohydrate quantity).

The GL is calculated as follows:

$$\frac{(\text{GI value of the food} \times \text{the quantity of carbohydrates of the serving in grams})}{100}$$

For example, for a food with a GI of 54 and an available 20 grams of carbohydrate per serving, the GL value is $(54 \times 20) / 100 = 10.8$

Watermelon is a good example of the importance of considering both GI and GL for foods. The GI for watermelon is high, in the 80s. But the actual quantity in grams of carbohydrates in a serving of watermelon is so low that it has only a minimal effect on blood sugar, and therefore a lower GL.

Both the GI and GL measures can be useful for determining the role carbohydrate-containing foods or meals play in the body. They help determine how blood sugar levels, and in turn insulin, will react after eating.

FOOD SOURCES OF CARBOHYDRATES

Carbohydrates are inexpensive and common in most diets. For example, clients can purchase several pounds of sweet potatoes for only a few dollars and have a week's supply of high-quality complex carbohydrates. Some other foods high in carbohydrates (over 60 percent of calories) include ready-to-eat and cooked cereals, whole grain breads, crackers, popcorn, rice, pasta, corn, potatoes, winter squash, and yams. Other food types and specific examples that contain carbs include the following:

- **Grains.** Bread, noodles, pasta, and cereal
- **Fruits.** Apples, bananas, berries, mangoes, melons, and oranges
- **Dairy.** Milk and yogurt
- **Legumes.** Dried beans, lentils, and peas
- **Snack foods and sweets.** Cakes, cookies, candy, and other desserts
- **Drinks.** Juices, soft drinks, sports drinks, and energy drinks that contain sugars
- **Vegetables.** Potatoes, carrots, broccoli, beets, and sweet potatoes

Vegetables high in starch, like potatoes, have more carbohydrates per serving than non-starchy vegetables, but they all have some carbohydrates. Examples of non-starchy vegetables are asparagus, broccoli, carrots, celery, green beans, lettuce and other salad greens, peppers, spinach, tomatoes, and zucchini.

Table 5.2 Common Foods and Carbohydrate Content (per 100 grams)⁹

Carbohydrate Source	Grams of carbohydrates per 100 grams of source	Carbohydrate Source	Grams of carbohydrates per 100 grams of source	Carbohydrate Source	Grams of carbohydrates per 100 grams of source
Almonds	4 g	Doughnut	49 g	Pistachios	19 g
Apple	9 g	Flounder	0 g	Plain Yogurt	6 g
Asparagus	1 g	Goat Milk	5 g	Pork Chop	0 g
Banana	19 g	Grapes	13 g	Potato	20 g
Barbeque Sauce	8 g	Hamburger	22 g	Prawns/Shrimp	0 g
Beef Sirloin	0 g	Hardboiled Egg	Trace	Raisins	64 g
Beer	2 g	Honey	76 g	Red Wine	Trace
Bread (Brown, 1 slice)	48 g	Human Milk (Breast Milk)	7 g	Rice	30 g
Broccoli	2 g	Jelly	69 g	Salami (Sliced)	2 g
Butter	Trace	Lettuce	1 g	Salmon	0 g
Cashews	28 g	Mango	15 g	Scallops	Trace
Celery	1 g	Margarine	Trace	Skim Milk	5 g
Cheddar Cheese	Trace	Mayonnaise	Trace	Spinach	1 g
Cheese Pizza	25 g	Mustard	21 g	Sponge Cake	53 g
Cheesecake	35 g	Onion	5 g	Swiss Cheese	Trace
Chicken	0 g	Orange	6 g	Tuna	0 g
Coconut	6 g	Oysters (Raw)	Trace	Turkey (Roasted)	0 g
Cod	0 g	Peanut Butter	13 g	Vegetable Oil	0 g
Coffee	0 g	Peanuts	6 g	Vinegar	1 g
Crab	0 g	Pickles	6 g	Walnuts	5 g
Cream Cheese (Plain)	Trace	Pineapple	12 g	Whole Milk	5 g

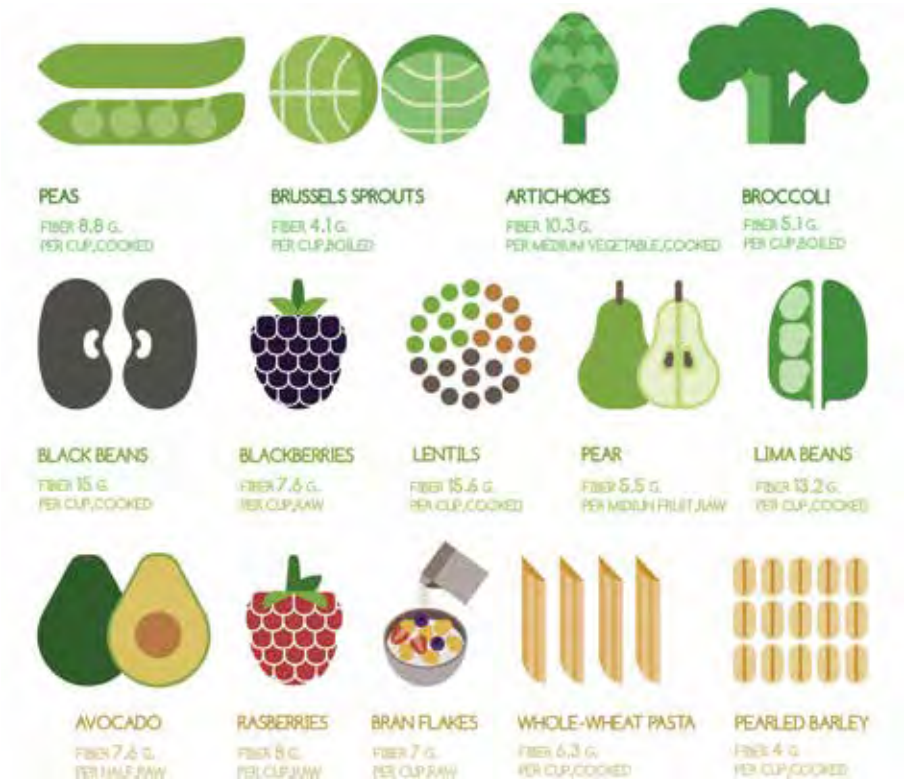
RECOMMENDED DIETARY ALLOWANCES FOR CARBOHYDRATES

Carbohydrates are essential nutrients that most people need in their diets in significant quantities for good overall health. The acceptable macronutrient distribution range for daily carbohydrate intake for adults is 45 to 65 percent of total daily calories, as reported by the National Academy of Medicine (NAM). This means that for a diet of 2,000 calories per day, carbohydrate intake should be around 900 to 1,300 calories. For weight loss, daily carbohydrate intake can drop to as low as 25 to 40 percent.

The National Research Council states that the optimal range for fiber per day is 21 to 38 grams. Some health experts recommend higher amounts and most adults in the US get only 12 to 18 grams of fiber per day. The 2015 Dietary Guidelines by the NAM recommend 14 grams of fiber per 1,000 calories consumed, so for a 2,000-calorie-per-day diet, this would mean 28 grams per day.

Due to individual differences, the amount of fiber needed to maintain a healthy and diverse gut microbiome varies. The recommended guidelines are general and clients can improve fiber intake by eating foods high in fiber or by using a fiber supplement.

Figure 4.5 Good Sources of Fiber



Healthy carbohydrate intake means consuming lower amounts of simple refined sugars, increasing fiber intake, and including more whole grain foods and complex carbohydrates. When choosing carbohydrates, it is also important to select more foods that have a lower GI value.

A simple place to start when choosing carbohydrates is to focus on a diversity of vegetables. Carbs from vegetables are moderate or low on the GI, are rich in fiber, and maximize vitamins and minerals without supplementation.

CARBOHYDRATES AND ATHLETES

The amount of carbohydrates an individual needs is based on their total output of energy throughout the day. Getting 40 percent of daily calories from **net carbohydrates** is a good baseline. Adjustments can then be made for appropriate recovery and progress with respect to an athlete's activity level and training phases.

When the timing of carbohydrate ingestion is right, this nutrient is used more quickly for energy and does not cause a rapid rise in insulin that could conflict with glucagon function and energy production. These functions are vital for high-performance muscle contractions during athletic activities. This also spares the body's glycogen stores. Proper timing means that the body is active and using energy as the ingested carbs enter the bloodstream.

When the body runs out of stored glycogen and is forced to use fatty acids as the primary source of energy, physical performance declines. Under glycogen depletion conditions, the body may also use proteins and amino acids for energy. This process is called **gluconeogenesis**. Endurance athletes call this "hitting the wall," when their body's glycogen stores become depleted and they must rely on other nutrients for energy production during training or events.

DID YOU KNOW:

The benefits of carbohydrate and electrolyte drinks for performance are less clear for exercise lasting under 90 minutes, assuming glycogen levels have been replenished before exercise. The benefits might not be immediate but may help reserve glycogen stores and prevent glycogen depletion on a day-to-day basis. Research indicates that many athletes may suffer from chronic glycogen depletion, with decreased performance and increased recovery time¹⁰. Drinking pre-exercise and during-exercise carbohydrate beverages, with personalized hydration and electrolytes, is an important sports nutrition practice to help athletes maintain a high level of performance.

For peak performance and health, athletes must consider the type of carbohydrates they eat, the time of day they eat them, their intake of nutrient **cofactors**, and adequate intake of the other essential nutrients. All these elements together help to maintain the body's glycogen stores and enhance energy production during exercise.

NET CARBOHYDRATES:

The total amount of carbohydrates minus dietary fiber.

GLUCONEOGENESIS:

The process of converting a non-carbohydrate substance into glucose for energy.

COFACTORS:

Substances that must be present for another substance to be able to perform a certain function.



PROTEIN

LEARNING OBJECTIVES

- 1 | Define key terms related to protein and amino acids.
- 2 | Explain the functions and physiological effects of protein and amino acids in the body.
- 3 | Distinguish between essential and non-essential amino acids.
- 4 | Understand the digestion and absorption of protein in the body.

Research confirms protein's role as a vital component of health and fitness. However, studies have also established diets too high in protein may be as detrimental as diets lacking sufficient amounts of protein and active individuals require more protein than people with a sedentary lifestyle.

Protein is an essential part of the diet—one of three nutritional macronutrients, along with fats and carbohydrates—and plays many roles in the body. It's roles include providing structure and growth, catalyzing reactions, signaling, supporting immune activity, and transporting across cell membranes. Proteins are not a primary source of energy, but they can be used for energy during intense exercise or when nutrition is inadequate.

AMMONIA:

A toxic metabolic waste product produced from the metabolism of nitrogen-containing compounds like protein and amino acids.

Active clients need to balance their intake of protein so as not to experience muscle loss but also to avoid the formation of harmful metabolic waste products. The body converts excess dietary protein to fat and increases the blood levels of the metabolic waste products **ammonia** and **uric acid**.

URIC ACID:

A toxic metabolic waste product filtered by the kidneys as a result of the metabolism of nitrogen-containing compounds.

PROTEIN

A protein is a macromolecule and a polypeptide, a compound containing 10 to over 100 molecular subunits. Each subunit is a small molecule known as an **amino acid** which are linked together by a **peptide bond**.

AMINO ACID:

An organic compound used as a precursor for other molecules in the body.

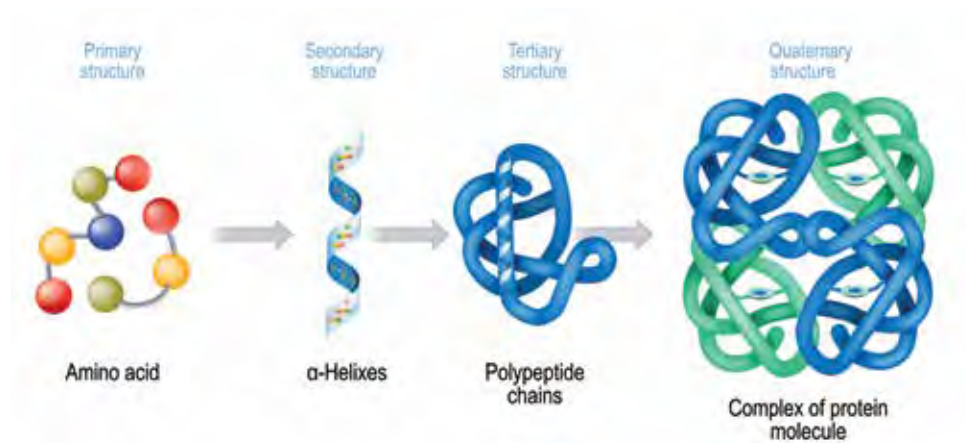
The shape of a protein determines its role and function in the body. There are four levels of structure in each protein:

PEPTIDE BOND:

The bond that links amino acids together to form a protein.

- The unique sequence of amino acids in a polypeptide chain that is determined by genetics makes the primary structure.
- The local folding of the polypeptide chain makes the secondary structure. The most common structures are the alpha-helix chain and the beta-pleated sheet.
- Combinations of chains and sheets make up the shapes of proteins. The tertiary structure is the three-dimensional shape of the polypeptide. The interactions of R groups between individual amino acids creates this 3-D structure.
- Some proteins are made of several polypeptides—known as subunits. The quaternary structure is formed based on the interactions between subunits.

Figure 5.1 Protein Structure



The amino acid is the primary structure that creates the secondary helix. A series of helices creates a polypeptide chain which, when combined with other polypeptide chains, creates the functional protein structure.

In terms of nutrition it is important to consider the amino acid subunits rather than whole proteins. About 20 amino acids are considered biologically important, but many more exist in nature and in the body. Amino acids are important not only for being the building blocks of protein but also for the individual roles they play in the body. For example, some amino acids are used in metabolic processes such as the **urea cycle** and others act as **neurotransmitters** that transmit nerve impulses.

Each amino acid is made of a central carbon atom known as the alpha carbon. Bonded to the alpha carbon are the following:

- An amino group: a chemical grouping, also known as a functional group, made up of nitrogen and hydrogen atoms
- A carboxyl group: a functional group containing carbon, oxygen, and hydrogen
- A hydrogen atom
- The R group: a unique functional group that varies depending on the type of amino acid

UREA CYCLE:

The metabolic process in which ammonia is converted to the waste product urea.

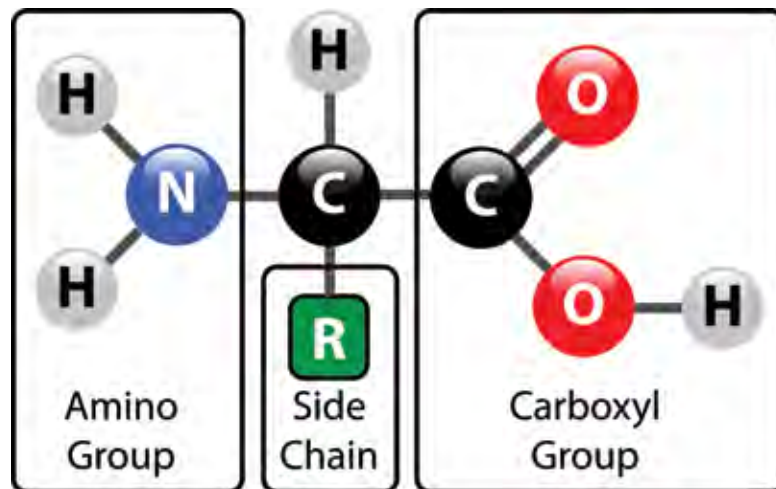
NEUROTRANSMITTER:

The molecule that transmits a signal across the synapse between two neurons.

DID YOU KNOW:

While dietary proteins and carbohydrates have uniquely different properties in both appearance and chemistry, when analyzed with bomb calorimetry, they produce the same amount of energy: a 4 kcal/gram value.

Figure 5.2 Amino Acid Structure



PEPTIDES:

Compounds consisting of two or more amino acids linked together by peptide bonds.

DEHYDRATION REACTION:

A chemical reaction that forms a bond and releases a molecule of water in the process.

HORMONES:

Signaling molecules secreted by an endocrine organ or gland.

DEOXYRIBONUCLEIC ACID (DNA):

The large molecule in the cell nucleus that contains the cell's genetic blueprint and determines how the cell will develop.

SIMPLE PROTEIN:

A protein made up of only amino acid subunits.

CONJUGATED PROTEIN:

A protein that includes amino acids as well as one or more non-amino acid units.

All amino acids have an amino group, a carboxyl group, and a unique side chain (R) group attached to a central carbon.

When amino acids attach to each other through covalent bonding, they form **peptides**. These peptide bonds are formed by a **dehydration reaction**. Disaccharides are also created when two smaller molecules link together through a dehydration reaction. To form a peptide through a dehydration reaction, the carboxyl group of one amino acid bonds to the amino group of another amino acid group, and a molecule of water is released.

A polypeptide is created when several amino acids link together via peptide bonds. Polypeptides have a free amino group at one end (called the N-terminal) and a free carboxyl group at the opposite end (the C-terminal). Proteins form when many polypeptides link together as a quaternary structure.

THE ROLE OF PROTEIN IN THE BODY

Protein is needed for the growth, maintenance, and repair of cells, including muscle cells; for the production of enzymes and **hormones**, and for **deoxyribonucleic acid (DNA)** expression. Protein constitutes most of the dry weight of body cells.

Proteins come in a range of sizes and shapes and are divided into two categories: **simple proteins** and **conjugated proteins**. Simple proteins consist only of amino acids, while conjugated proteins also have non-protein molecules or atoms as part of their structures.

Table 5.1 Simple and Conjugated Proteins and Sources

PROTEIN	TYPE	SOURCE
Serum albumin	Simple	Blood
Lactalbumin	Simple	Milk
Ovalbumin	Simple	Eggs
Myosin	Simple	Muscle
Collagen	Simple	Connective tissue
Keratin	Simple	Hair
Nucleic acid	Conjugated	Chromosomes
Lipoprotein	Conjugated	Cell membranes
Glycoprotein	Conjugated	Blood
Hemoglobin	Conjugated	Blood
Phosphoprotein	Conjugated	Milk

Proteins are diverse molecules with several unique properties and roles:

- **Contractile.** Actin and myosin allow muscles to contract and relax, and therefore to move.
- **Hormonal.** Proteins like insulin, **growth hormone (GH)**, and insulin-like growth factors carry signals throughout the body to regulate actions of cells and tissues.
- **Structural.** Structural proteins, like collagen, provide support and structure in the body.
- **Transporter.** Proteins like hemoglobin carry other compounds and nutrients.
- **Enzymes.** Enzymes are proteins that catalyze reactions in the body.
- **Receptors.** Some proteins act as receptors, regulating gene expression and the transportation of molecules into and out of cells.

GROWTH HORMONE (GH):

a hormone released from the pituitary gland to stimulate growth, cell regeneration and repair, and cell reproduction. GH also acts homeostatically to increase blood glucose levels.

RIBONUCLEIC ACID (RNA):

The substance that carries the coded genetic information from the DNA in the cell nucleus to the ribosomes, where the instructions are translated into the form of protein signaling molecules.

ESSENTIAL AMINO ACIDS:

Amino acids the body cannot make and that must be consumed nutritionally.

NON-ESSENTIAL AMINO ACIDS:

amino acids the body can make on its own and that do not need to be consumed.

CONDITIONAL AMINO ACIDS:

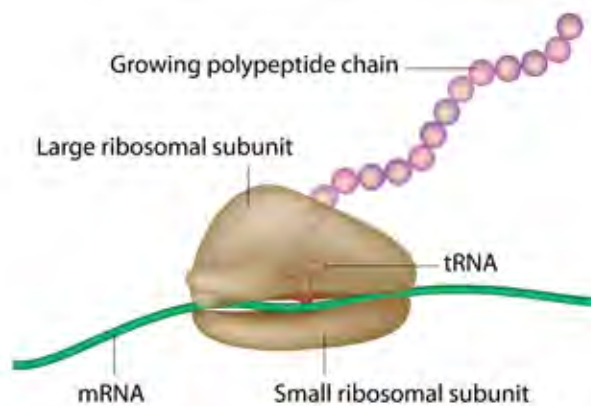
Amino acids that the body can make. Special populations or circumstances may warrant inclusion of these in the diet.

DID YOU KNOW:

DNA contains thousands of genes or codes for producing proteins. Creating proteins from genes takes two steps: transcription and translation and together, these steps are known as gene expression.

In transcription, information stored in the genes of the DNA molecule is transcribed into **ribonucleic acid (RNA)**. Both RNA and DNA are made up of a chain of nucleotide bases, but with slightly different chemical properties. Messenger RNA (mRNA) carries information, or message, from DNA out of the nucleus and into the cytoplasm for translation.

During translation, the mRNA interacts with a specialized complex called a ribosome, which reads the sequence of mRNA bases and transfer RNA (tRNA) assembles a protein, one amino acid at a time.



AMINO ACIDS

Nutritionally, amino acids are classified based on the dietary needs of the body. **Essential amino acids** cannot be made in the body and must be included in the diet while **non-essential amino acids** can be produced in the body when needed. **Conditional amino acids** are amino acids necessary in the diet for special circumstances, such as illness or intense athletic training. A diet with a wide variety of foods generally includes all of the nutritionally important amino acids.

Table 5.2 Nutritional Status of Amino Acids

ESSENTIAL	NON-ESSENTIAL	CONDITIONAL
Histidine	Alanine	Alanine
Isoleucine	Arginine	Arginine
Leucine	Cysteine	Cysteine
Lysine	Citrulline	Glutamine
Methionine	Glutamic Acid	Glycine
Phenylalanine	Glutamine	Proline
Threonine	Proline	Serine
Tryptophan	Serine	Tyrosine
Valine	Taurine	
	Tyrosine	

AMINO ACID REVIEW

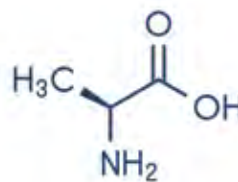
Some amino acids only act as components of proteins while others have expanded functions as biochemical intermediates or **precursors** of other amino acids or substances. Some amino acids function in all these roles.

PRECURSORS:

Intermediate substances in the body's production of another substance.

ALANINE

Alanine is a non-essential amino acid found in high concentrations in most muscle tissue and is involved in the glucose-alanine cycle. During exercise, glycogen stores in muscle are broken down to glucose and then to a three-carbon-atom molecule pyruvate. Some of the pyruvate is used directly for energy by the muscle, while the rest is converted to alanine. The alanine is transported through the bloodstream to the liver and converted back to glucose.



alanine

NITRIC OXIDE (NO):

A free radical that increases blood flow through vasodilation.

ARGININE

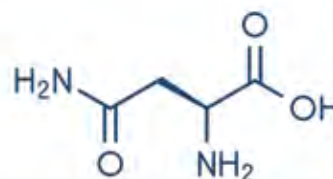
Arginine is a non-essential amino acid that plays a role in stimulating the release of GH and insulin-like growth factor. These increases may help reduce body fat, improve healing and recovery, increase muscle growth rate, increase muscle mass, and boost **nitric oxide (NO)** levels to improve blood flow.



arginine

ASPARAGINE

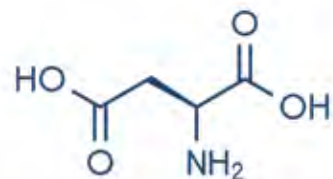
Asparagine is a non-essential amino acid involved in the proper functioning of the central nervous system. It stabilizes the nervous system by preventing both extreme nervousness or calm.



asparagine

ASPARTIC ACID

Aspartic acid, also referred to as L-aspartic acid or L-aspartate, is a non-essential amino acid shown to help reduce ammonia levels in the blood after exercise. The artificial sweetener aspartame contains aspartic acid and it is present in all protein containing foods, both animal and plant based.



aspartic acid

BRANCHED-CHAIN AMINO ACIDS (BCAAs):

Amino acids with chemically branched R groups. They are used for energy during strenuous physical activities.

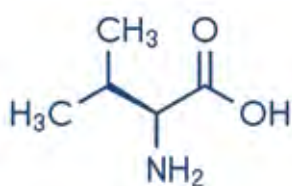
BRANCHED-CHAIN AMINO ACIDS

The **branched-chain amino acids (BCAAs)** include isoleucine, leucine, and valine. Together, these three amino acids make up about 35 percent of the amino acid content of muscle tissue and is used by the body for energy. Under conditions of stress, injury, or exercise, the body uses a disproportionately high amount of the BCAAs to maintain nitrogen balance.

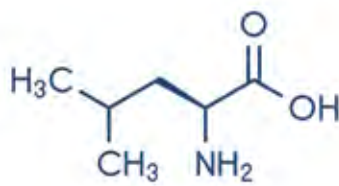
BCAAs have a history of supplemental and medicinal use for patients in stressed states, such as from burns, surgery, trauma, and starvation to help stimulate protein synthesis and maintain nitrogen balance. Additionally, leucine has other growth-related metabolic effects, including releasing GH and insulin and playing a role in controlling protein production.

Some of the related benefits of BCAA supplementation observed include the following:

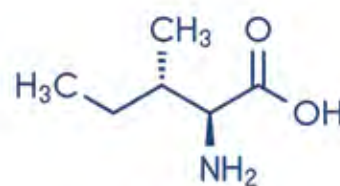
- Increased exercise endurance
- Reduction of exercise-related fatigue
- Improved mental performance
- Increased energy levels
- Stimulated protein synthesis
- Improved immune system function
- Increased lean body mass
- Increased strength



valine



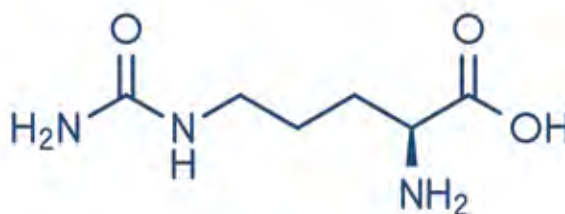
leucine



isoleucine

CITRULLINE

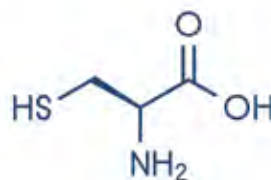
Citrulline is a non-essential amino acid that plays a role in the urea cycle for the removal of ammonia from the blood. It may also increase NO levels, improve exercise performance, and increase muscle protein synthesis, while reducing exercise-related muscle soreness.



citrulline

CYSTEINE

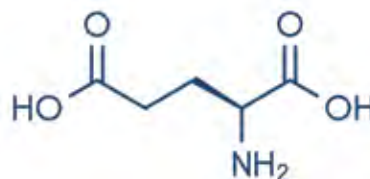
Cysteine is a non-essential sulfur-bearing amino acid that plays a role in energy production that the body manufactures from methionine and serine. Cysteine is important in the production of protein, hair, skin, connective tissues, connective tissue growth factor, taurine, and insulin. It also helps form glutathione, which is an important antioxidant and detoxifying agent.



cysteine

GLUTAMIC ACID

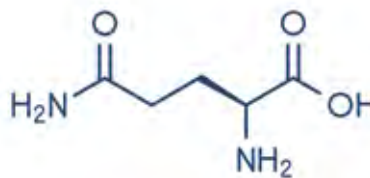
Glutamic acid, also known as glutamate, is a non-essential amino acid that acts as an intermediary in the Krebs cycle and is important for the metabolism of carbohydrates. It is also involved in the removal of ammonia from the muscles.



glutamic acid

GLUTAMINE

Glutamine is one of the most plentiful non-essential amino acids present in the body. Researcher suggests that people under stress from injury or disease have decreased glutamine levels that correlates with poor immune system function and



glutamine

DID YOU KNOW:

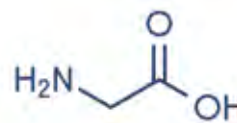
At certain times, glutamine can make up more than half of the amino acid pool in skeletal muscle. This large, sustained amount of glutamine allows the body to make use of it as needed like in times of stress.

reduced protein synthesis. When patients were provided with supplemental amounts of glutamine, their immune system function improved, and nitrogen balance was restored.

Glutamine is also reported to have anti-catabolic effects, reduce cortisol levels, improve wound healing, act as an energy source in certain cells, elevate GH levels, stimulate glycogen synthesis, combat overtraining syndrome, promote protein synthesis, support the blood buffering system, and promote gastrointestinal tract health.

GLYCINE

Glycine is a non-essential amino acid that is synthesized from serine, with folate acting as a coenzyme (enzyme cofactor), and is an important precursor of many substances in the body, including protein, DNA, phospholipids, collagen, and creatine. It is also a precursor



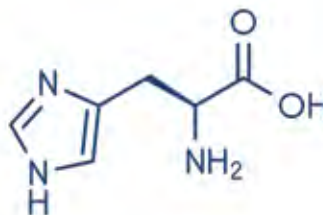
glycine

in the release of energy and has been shown to increase GH levels. Glycine is found in high amounts in connective tissues.

Additionally, glycine is used by the liver in the elimination of toxic substances and in the formation of bile salts. It promotes proper functioning of the central nervous system and is an inhibitory neurotransmitter.

HISTIDINE

Histidine is an essential amino acid, important in the growth and repair of human tissue and the formation and maintenance of hemoglobin, the oxygen transport protein in red blood cells. Histidine is used in the body to make **histamine** and **carnosine**.



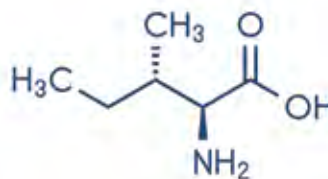
histidine

HISTAMINE:

A compound and neurotransmitter involved in local immune response and in regulation of functions in the digestive tract.

ISOLEUCINE

Isoleucine is an essential amino acid and a BCAA needed for the formation of hemoglobin. It is involved in the regulation of blood sugar and is metabolized for energy in muscle tissue during exercise.



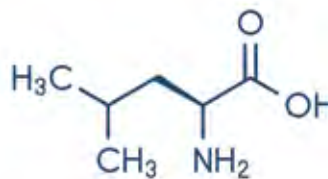
isoleucine

CARNOSINE:

A dipeptide made of alanine and histidine, present in large amounts in muscle and brain tissue.

LEUCINE

Leucine is an essential amino acid and BCAA important in energy production during exercise. More than half of dietary leucine may be used for energy in contracting muscles and it is a limiting amino acid if supplemental amounts are not taken to compensate for losses during training.



leucine

Leucine may also stimulate the release of insulin, which increases protein synthesis and inhibits protein breakdown.

LYSINE

Lysine is an essential amino acid found in large quantities in muscle tissue. It is needed for proper growth and bone development and it aids in calcium absorption. Lysine enhances immune system function and may be useful for fighting cold sores and herpes viruses.



lysine

CARNITINE:

An amino acid derivative found mostly in muscle tissue that helps the body use fat for energy.

Together with methionine, iron, and vitamins B1, B6, and C, it helps form **carnitine**, a compound that the body needs for energy production from fatty acids. Lysine deficiency limits protein synthesis and the growth and repair of tissues, particularly connective tissues.

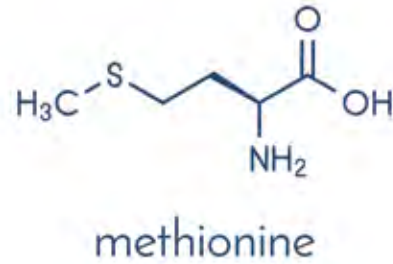
TRANSMETHYLATION:

the metabolic process in which an amino acid donates a methyl group to another compound.

METHIONINE

Methionine is an essential sulfur-bearing amino acid involved in **transmethylation**, a metabolic process that is vital to the manufacture of several compounds. It is involved in the synthesis of creatine and important for muscle performance and is a

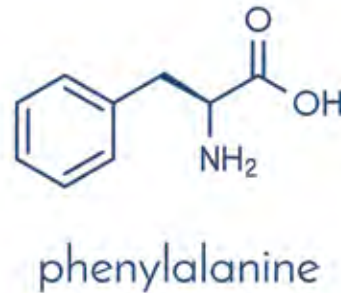
limiting amino acid in many proteins, especially in plant proteins. It functions in the removal of metabolic waste products from the liver and assists in the breakdown of fat and the prevention of fatty buildup in the liver and arteries.



PHENYLALANINE

Phenylalanine is an essential amino acid and a precursor of the nonessential amino acid tyrosine. It is a precursor of several important metabolites, such as the skin pigment melanin and several catecholamine neurotransmitters, including epinephrine, norepinephrine, and dopamine. The

catecholamines are important in memory and learning, locomotion, sex drive, tissue growth and repair, immune system functioning, and appetite control. Phenylalanine suppresses appetite by increasing the brain's production of norepinephrine and **cholecystokinin**.



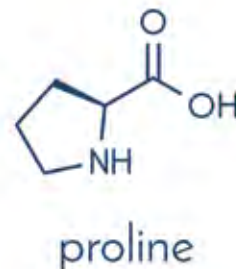
CHOLECYSTOKININ:

The hormone that is thought to be responsible for signaling fullness after eating.

PROLINE

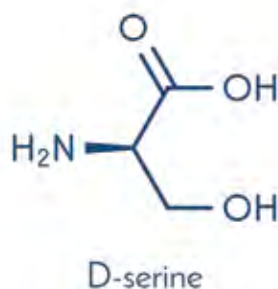
Proline is a non-essential amino acid occurring in high amounts in collagen tissue that can be synthesized from and converted to glutamic acid. It is important in the maintenance and healing of collagen tissues in the skin, tendons, and cartilage. Proline and hydroxyproline are

typically provided in supplements from hydrolyzed collagen or gelatin and they may improve joint function and mobility and reduce pain and stiffness, especially in knee joints.



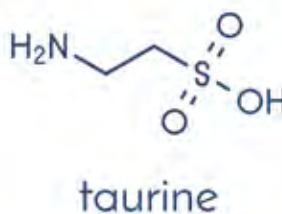
SERINE

Serine is a non-essential amino acid found in proteins and derived from glycine. Its metabolism leads to the formation of many important substances, such as choline and phospholipids, which are needed to form some neurotransmitters and are used to stabilize cell membranes.



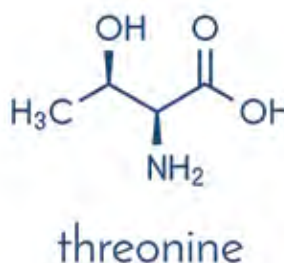
TAURINE

Taurine is a non-essential sulfur-bearing amino acid that plays a major role in brain tissue, nervous system functioning, blood pressure regulation, and in the transportation of electrolytes across cell membranes. It is found in the heart, muscle tissue, central nervous system, and the brain. Other reported functions of taurine include bile acid function, detoxification of xenobiotics (foreign substances in the body), membrane stabilization, antioxidant activity, osmoregulation, cell proliferation, modulation of neuronal excitability, and intracellular and extracellular calcium regulation.



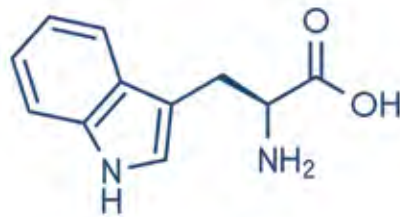
THREONINE

Threonine is an essential amino acid and is an important component of collagen, tooth enamel, protein, and elastic tissue. It can also function as a lipotropic agent, a substance that prevents fatty buildup in the liver. Supplemental threonine has a reported medical use in the treatment of depression in patients with low threonine levels.



TRYPTOPHAN

Tryptophan is an essential amino acid necessary to produce vitamin B3 and the neurotransmitters serotonin and melatonin. Taking supplemental vitamin B3 can help conserve tryptophan for its other functions. Supplemental tryptophan has long been used for its pronounced calming effects, for insomnia, and for depression.

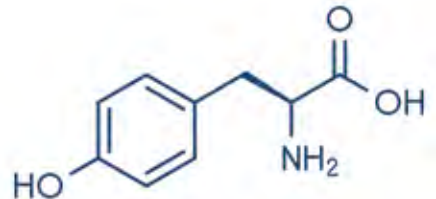


tryptophan

Tryptophan is one of the least abundant amino acids in food, which makes it one of the limiting essential amino acids. Some foods that are high in tryptophan are cottage cheese, pork, wild game, duck, and avocado. Eating these foods along with vitamin B3 and the cofactors vitamin B6 and magnesium may be useful for some.

TYROSINE

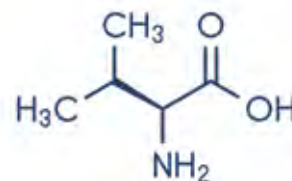
Tyrosine is a non-essential amino acid that is made from phenylalanine and serves as the foundation for thyroid hormone. Supplementation with L-tyrosine can have a sparing effect on phenylalanine, leaving phenylalanine available for functions not associated with tyrosine formation. It is a precursor of the catecholamines, regulates appetite, and aids in melanin skin pigment production.



tyrosine

VALINE

Valine is an essential amino acid a BCAA. As with isoleucine and leucine, valine is an integral part of muscle tissue and may be used for energy when muscles are being exercised and is involved in tissue repair, nitrogen balance, and muscle metabolism.



valine

PROTEINS, AMINO ACIDS, AND ENERGY

Under conditions of severe calorie restriction, the body releases amino acids from muscle tissue for use as energy. Even in a well-fed state, the body will use amino acids for energy during exercise and sometimes at rest. This catabolism (breakdown) of protein is most likely to occur during intense workouts, like power exercises and prolonged endurance activities. Catabolism may also occur when the body runs out of consumed carbohydrates or stored glycogen from muscle and liver tissue. Muscles use the BCAAs to supply a limited amount of energy during strenuous exercise.

Research has shown that although the body can utilize all three BCAAs for energy during exercise, it uses more leucine than the others. A trained individual uses leucine even when at rest. This makes the BCAAs **limiting nutrients**, nutrients that, through their absence or presence, restrict the use of other nutrients or the body's normal functions.

LIMITING NUTRIENTS:

A nutrient that limits reactions, functions, and use of other nutrients because it is absent or limited.

DID YOU KNOW:

Even with a healthful, balanced diet, a limiting nutrient can restrict muscle growth. For example, a client consumes 100 grams of protein per day, with all the essential amino acids in equal amounts. Their body will use a percentage of leucine for energy during a tough training session which reduces the amount of leucine available for growth and repair of muscles after training. Even if the body has access to adequate amounts of the other amino acids, this diminished leucine supply limits muscle growth. When the leucine supply runs out, protein formation will be negatively affected because leucine is an essential amino acid.

THE QUALITY OF PROTEINS

Not all proteins are nutritionally equal. Some include more essential amino acids and are better suited for growth and muscle development. Scientists have developed several different methods to rate or classify proteins.

COMPLETE VERSUS INCOMPLETE PROTEINS

Because adequate protein intake is essential for optimum growth in children, the World Health Organization has conducted research on protein requirements. It was determined that not all proteins supply the proper amounts and proportions of the amino acids necessary for adequate growth and development.

COMPLETE PROTEINS:

A protein that contains the essential amino acids in amounts that are sufficient for the maintenance of normal growth rate and body weight.

INCOMPLETE PROTEINS:

A protein that is deficient in one or more of the essential amino acids.

Complete proteins are proteins that contain the essential amino acids in amounts sufficient for the maintenance of normal growth rate and body weight. Complete proteins have a high biological value. Most animal-based foods have complete proteins.

Incomplete proteins are deficient in one or more of the essential amino acids. This amino acid deficiency creates a limiting amino acid condition, which adversely affects growth and development rates. Most plant proteins are incomplete but can be combined in ways that provide a complete complement of essential amino acids.

Considering the dynamics of amino acids in the body, even high-quality proteins can be considered incomplete when demands are greater than the amino acids availability. Proper proportions of essential and nonessential amino acids are required for optimum growth and recovery meaning clients should consume a diverse source of high-quality protein throughout the day to ensure an adequate intake of amino acids.

DID YOU KNOW:

Proteins are the basis for cellular communication and are critical in sending and receiving messages. Any cell (in plants or animals) that is capable of receiving a signal within the living structure contains protein which means plants contain protein, but sometimes in only trace amounts. Portions of the protein in plants may also be bound in cellulose, a plant starch, which human digestive systems cannot digest which limits how much protein a person can access from plant foods.

FREE-FORM AND PEPTIDE-BONDED AMINO ACIDS

The terms free-form and peptide-bonded are often used to describe the amino acid content of food or supplements. Peptide-bonded amino acids are amino acids that are linked together. Dipeptides are two amino acids linked together, tripeptides are three amino acids linked together, and polypeptides are four or more amino acids linked together. The intestines can absorb free-form, dipeptide, and tripeptide amino acids but not polypeptides.

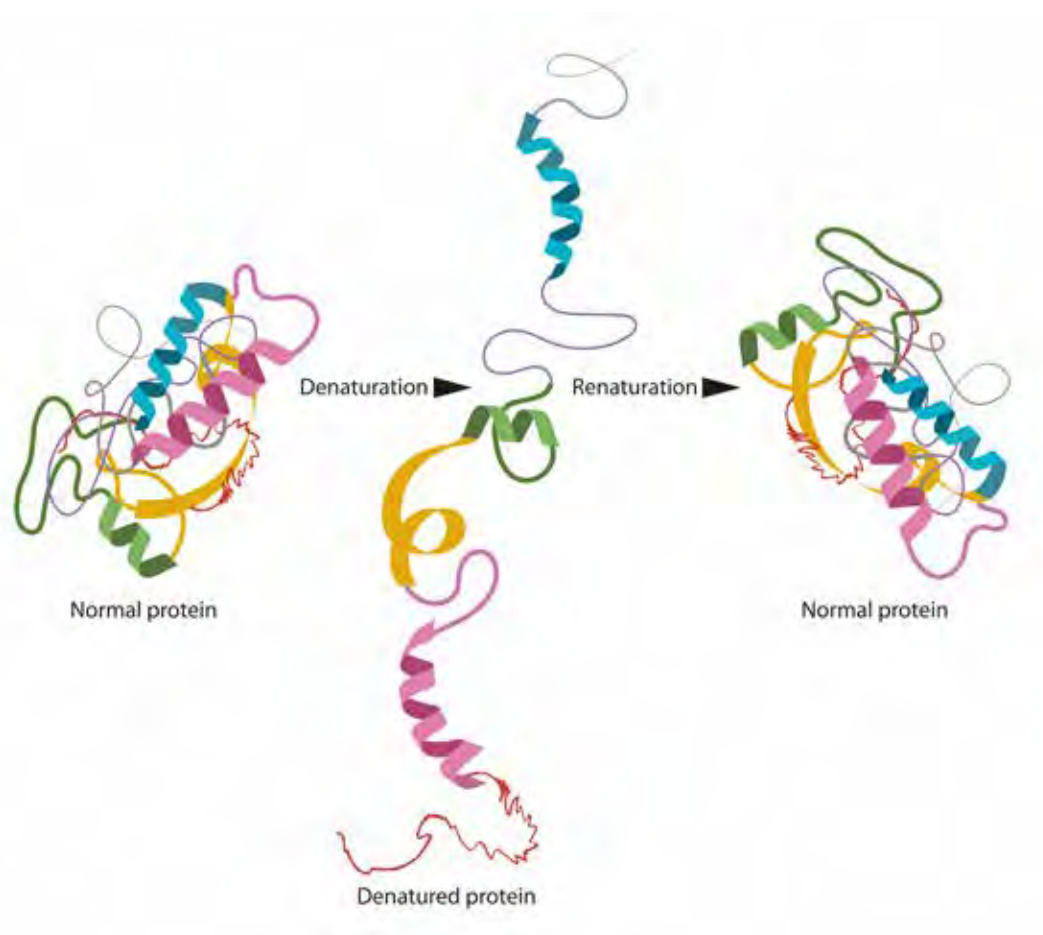
The use of free-form amino acids is still common in clinical applications when intravenous solutions are used to supply amino acids directly into the bloodstream. Free-form amino acids can also be used to fortify food proteins. Taking BCAA supplements with meals, for instance, can compensate for the loss of the amino acids used for energy during a workout. Free-form amino acids are also sometimes added to protein products to selectively increase the amino acid content.

A mixture of free-form and peptide-bonded amino acids could be better than free-form amino acids alone because the intestines can better absorb mixtures for transport into the bloodstream. The upper small intestine is better able to absorb amino acids in di- and tri-form.

PROTEIN DIGESTION

Several factors can change a protein's shape and chemistry. Changes in temperature (cooking), pH (digestion), high salt concentrations, alcohol, mechanical agitation, and exposure to chemicals alter the shape of a protein. When protein loses its shape (bonds are broken), it also loses its function. This is known as denaturation.

Figure 5.3 The Denaturation and Renaturation of Protein



The body digests protein through several steps, beginning with cooking and the mechanics of chewing and followed by chemical and pH changes in the digestive tract.

PEPSIN:

An enzyme released in the stomach that breaks proteins down to smaller peptides and free amino acids.

CHYME:

the mass of partially digested food and gastric juices that moves from the stomach to the small intestine.

PROTEASE:

An enzyme that is produced in the pancreas and plays a large role in the digestion of protein, primarily in the small intestine.

CHYMOTRYPSIN:

A digestive enzyme secreted by the pancreas and converted to an active form by trypsin. It breaks down proteins in the small intestine.

TRYPSIN:

An enzyme that breaks down and digests protein in the small intestine.

MOUTH TO STOMACH

Chewing mechanically breaks down large chunks of protein into smaller pieces that can be swallowed. Saliva is excreted to help the bolus move down the esophagus and there are no enzymes present in saliva that act on protein.

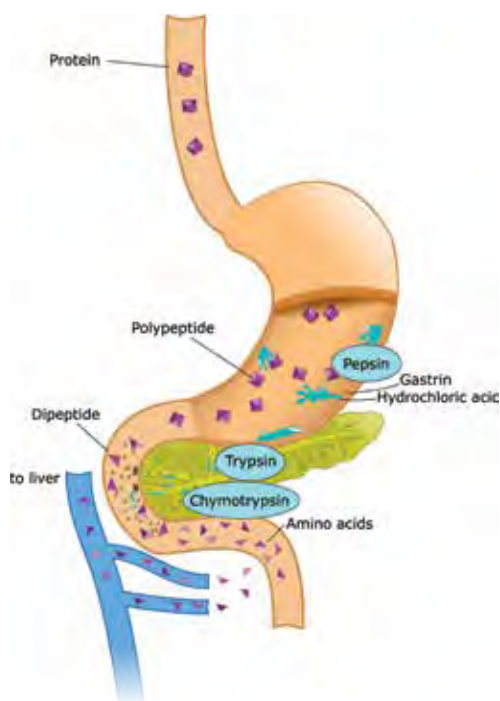
Once food is in the stomach, gastric juices—made of hydrochloric acid and **pepsin** - break down the protein. The acidity inside the stomach environment unfolds any parts of the proteins that still retained some three-dimensional structure after cooking.

Pepsin is secreted by the lining of the stomach to break peptide chains into shorter fragments. The mechanical churning of the stomach turns partially digested protein into **chyme**. Protein takes longer to digest in the stomach than carbohydrates but takes less time than fats.

SMALL INTESTINE TO BLOODSTREAM

Most protein digestion happens in the small intestine with the help of **protease**. When chyme enters the small intestine, the pancreas releases **chymotrypsin** and **trypsin**. The cells of the small intestine release more enzymes to complete the process of breaking down proteins into amino acids and the contractions of the small intestine mix and send the amino acids to absorption sites.

Figure 5.4 The Digestion of Protein



Transport proteins using the energy from ATP move the amino acids through the intestinal cells and into the blood to be sent to the liver before being sent out to other cells or before being broken down further.

About 90 percent of proteins do not get broken down any further than their constituent amino acid subunits. However, if they are broken down beyond the amino acid level—as happens in very high-protein diets—then nitrogen-containing ammonia is released. This substance is toxic in the body and must be excreted.

Ammonia is converted into urea and transported to the kidneys to be removed from the body in urine.

DID YOU KNOW:

When blood glucose levels are low, the hormones cortisol and epinephrine can bind to the liver to signal and activate gluconeogenesis. Gluconeogenesis is a survival mechanism that ensures glucose is spared and readily available for the brain and this process allows serum amino acids to be broken down to help regain homeostasis (increased blood glucose).

Though this does take place in different organs, the liver does the bulk of the work in converting these non-sugar compounds to readily usable energy in the blood. Having excess BCAAs can be beneficial to help spare muscle protein from being broken down when energy availability is low..

FOOD SOURCES OF PROTEIN

Proteins are found in both animals and plants and protein and fat are usually found together in foods, especially animal products. Most animal proteins tend to be of higher quality than plant proteins and contain the proper proportions of essential amino acids.

Most plant protein sources, such as beans and peas, are incomplete in terms of essential amino acid content. Combinations of different plant proteins are required to create a complete protein source. Clients can get complete proteins from plants by combining legumes and whole grains, such as black beans with brown rice.

Some of the best low-fat sources of protein include low-fat/skim milk and other low-fat dairy products, fish, shellfish, lean red meats with the fat trimmed, and poultry with the skin removed.

Table 5.3 Common Foods and Protein Content (per 100 grams)

Protein Source	Grams of protein per 100 grams of source	Protein Source	Grams of protein per 100 grams of source
Almonds	17 g	Beer	0.3 g
Apple	0.2 g	Bread (Brown,1 slice)	8 g
Asparagus	2 g	Broccoli	3 g
Banana	0 g	Butter	0.4 g
Barbeque Sauce	2 g	Cashews	18 g
Beef Sirloin	24 g	Celery	0.9 g

Table 5.3 Common Foods and Protein Content (per 100 grams) - Continued

Protein Source	Grams of Protein per 100 grams of source	Protein Source	Grams of Protein per 100 grams of source
Cheddar Cheese	26 g	Oysters (Raw)	11 g
Cheese Pizza	9 g	Peanut Butter	23 g
Cheesecake	4 g	Peanuts	17 g
Chicken	29 g	Pickles	0 g
Coconut	5 g	Pineapple	0.5 g
Cod	21 g	Pistachios	19 g
Coffee	0.2 g	Plain Yogurt	4 g
Crab	20 g	Pork Chop	22 g
Cream Cheese (Plain)	8 g	Potato	2 g
Doughnut	6 g	Prawns/Shrimp	23 g
Flounder	25 g	Raisins	1 g
Goat Milk	3 g	Red Wine	0.2 g
Grapes	1 g	Rice	2 g
Hamburger	14 g	Salami (Sliced)	19 g
Hardboiled Egg	12 g	Salmon	20 g
Honey	0.4 g	Scallops	23 g
Human Milk (Breast Milk)	1 g	Skim Milk	10 g
Jelly	0.6 g	Spinach	5 g
Lettuce	1 g	Sponge Cake	6 g
Mango	0 g	Swiss Cheese	29 g
Margarine	0.4 g	Tuna	23 g
Mayonnaise	2 g	Turkey (Roasted)	28 g
Mustard	29 g	Vegetable Oil	Trace
Onion	0.9 g	Vinegar	0.4 g
Orange	0 g	Walnuts	11 g
		Whole Milk	3 g

RECOMMENDED DIETARY ALLOWANCES FOR PROTEIN

Table 5.4 RDA for Protein

Category	Age Group	RDA (g/day)	Category	Age Group	RDA (g/day)
Male	14-18	52	Female	14-18	46
	19-30	56		19-30	46
	31-50	56		31-50	46
	51-70	56		51-70	46

PROTEIN AND ATHLETES

Athletes typically require a diet high in protein because of the demands placed on their bodies. Different types and intensities of sports and training require different body compositions and specific amounts of protein. As these factors change throughout an athletic season or as an athlete's body composition changes, their protein needs will also change.

A nutrition coach should consider the following when making protein suggestions to athletes:

- Protein can be broken down and used or stored as fat. To prevent fat storage, the research suggests distributing protein intake throughout the day rather than eating large amounts in one sitting. This strategy allows the amino acid constituents to be used for muscle maintenance, growth, and recovery instead of stored.
- For building lean body mass, daily protein intake must maintain a positive muscle protein balance. Daily intake in the range of 1.4–2.0g protein per kilogram of body weight per day (g/kg/d) is a suggested range and is sufficient for most exercise that is intended to develop mass.
- Carbohydrate intake can also help offset muscle damage and promote recovery through insulin and its downstream effects on the MAPK pathway, which is a chain of proteins in the cell that communicates a signal from a receptor on the surface of the cell to the DNA in the nucleus of the cell. Athletes should consume adequate protein and carbs before and after training.
- Fitness professionals should prioritize whole foods for protein in most nutrition plans but include supplemental protein for athletes if needed. Daily protein needs rise with the intensity and duration of training which creates a problem with packing the gut and speed of assimilation. Supplemental protein can bridge the gap and help athletes get more protein more efficiently.



FATS

LEARNING OBJECTIVES

- 1 | Understand the roles of lipids in the body.
- 2 | Identify the different types of fats and their major functions.
- 3 | Explain the differences between essential and nonessential lipids.
- 4 | Explain how the body digests fat.
- 5 | Identify the nutritional sources of fats.

LIPIDS:

Organic biomolecules soluble in organic solvents, but not water.

BETA-OXIDATION:

The catabolic metabolism of fatty acids to generate the molecules needed to synthesize adenosine triphosphate.

CHOLESTEROL:

A lipid found in all cells and used in digestion, hormone production, and vitamin absorption.

FATTY ACIDS:

A chain of carbon and hydrogen atoms with a carboxyl group (carbon and oxygen) at one end.

GLYCEROL:

A three-carbon alcohol molecule and the structural backbone of lipids.

TRIGLYCERIDE:

Three fatty acids linked to a molecule of glycerol.

Fats, also known as **lipids**, have long been demonized in health and nutrition. However, this macronutrient plays an important role in human physiology and is just as important as proteins and carbohydrates. Fats are dense and yield high amounts of energy through the **beta-oxidation** pathway. They differ from proteins and carbohydrates in both digestion and assimilation. Like proteins, there are both essential and nonessential fats, and, like carbohydrates, there are many different structural fats with different roles in the body.

Lipids are a necessary part of a balanced diet for numerous reasons, including the following:

- They store and help use the fat-soluble vitamins A, D, E, and K.
- They maintain the function and integrity of cellular membranes.
- They provide a concentrated source of energy.
- They make meals more palatable and filling.

FATS

Here are the major lipids found in the human diet and in the body:

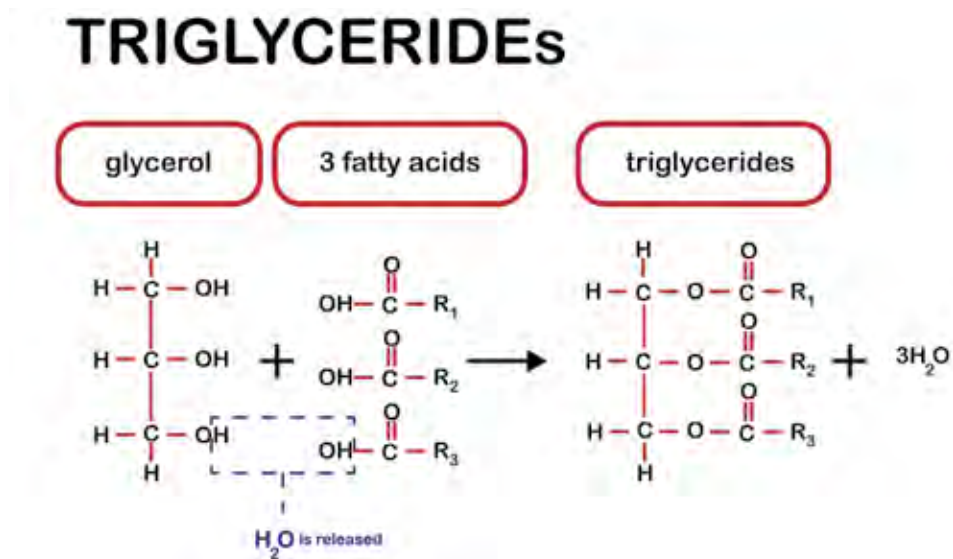
- Triglycerides
- Fatty acids
- Essential fatty acids
- Omega-3 fatty acids
- Gamma linolenic acid
- Medium chain triglycerides
- Phospholipids
- Lecithin
- **Cholesterol**

The building blocks of lipids are **fatty acids** and the small molecule **glycerol**. Fatty acids are long chains of hydrogen and carbon, ranging from 4 to 36 carbon atoms in length. They are classified by the number of carbons in their chains as follows:

- Short-chain fatty acids have 4 or 5 carbon atoms.
- Medium-chain fatty acids contain 6–12 carbons.
- Long-chain fatty acids include 19–23 carbon atoms.
- Anything with 20 or more carbons is a long-chain fatty acid.

Three fatty acids linked to a molecule of glycerol make a **triglyceride**. There is a wide range of types of fatty acid molecules leading to a wide variety of triglycerides.

Figure 6.1 Formation of Triglycerides.



Glycerol and three fatty acids combine to form a triglyceride and water.

Nutritional fats are classified into two types: **saturated fats** and **unsaturated fats**. The difference in molecular structure between these two types of fats is minimal and involves single- and double-carbon bonds, but their roles in the body differ significantly. For example, saturated fats are known to raise levels of **low-density lipoprotein (LDL) cholesterol**, which is considered the “bad” type of cholesterol.

Unsaturated fats have one or more double bonds between carbon atoms in the fatty acid chains. These can be further divided into **monounsaturated fatty acids**—with just one double bond—and **polyunsaturated fatty acids**—with more than one double bond. Unsaturated fats make up structural components of cells and are important for proper growth, development, and maintenance of body tissues. These fats are derived from plants and plant-based foods.

Saturated fats contain the maximum number of hydrogen atoms; they are saturated. They have no carbon double bonds. This small change in molecular structure means they are in a solid state at room temperature, while unsaturated fats remain in a liquid state.

Saturated fatty acids are used for energy or stored as bodyfat. The shorter the fatty acid length, the easier it is to metabolize for energy. The longer fatty acids can also be used as energy or stored as bodyfat but have other functions as well, such as cell membrane structure.

SATURATED FATS:

A fat or fatty acid with single bonds between carbons.

UNSATURATED FATS:

A fat or fatty acid with one or more double bonds between carbons.

LOW-DENSITY LIPOPROTEIN (LDL) CHOLESTEROL:

“Bad” cholesterol building up in and contributing to the hardening of arteries.

MONOUNSATURATED FATTY ACIDS:

Fatty acids with just one double bond between carbons.

POLYUNSATURATED FATTY ACIDS:

Fatty acids with more than one double bond.

THE ROLE OF LIPIDS IN THE BODY

Fats have a long-standing reputation in health and fitness, both positive and negative. Medical research has linked a diet high in saturated fats and cholesterol to diseases such as cancer, heart disease, and obesity. On the other hand, fats are essential to the normal functioning of cells and organ systems. Fats tend to make foods taste better, which can lead to weight-control issues. The importance of lipids in the body is evident, and restricting or strictly limiting fat intake should be avoided unless prescribed by a medical professional. Optimal health comes from the right balance between all three macronutrients.

The main functions of nutritional lipids include the following:

- A major fuel source during exercise
- Bodyfat stores for insulation and temperature regulation
- Absorption and storage of fat-soluble vitamins
- Energy storage
- A supply of essential fatty acids that the body cannot synthesize
- Protective padding for body structures and organs
- Structure in membranes and other cell structures
- Healthy skin
- Building blocks for other biomolecules
- Hormone synthesis

ADIPOSE TISSUE:

Loose connective tissue made of adipocytes for storing excess fats in the body.

LIPOGENESIS:

The metabolic process forming fat for storage in adipocytes.

LIPOLYSIS:

The breakdown of lipids for energy occurring during fasting and exercise when energy availability and insulin are low.

PROSTAGLANDINS:

Hormones involved in the inflammatory response to injury as well as female reproductive phases.

STEROID HORMONES:

Hormones derived from cholesterol, including estrogen and testosterone.

Once cellular energy needs have been met in the body, excess energy (converted to triglycerides and fatty acids) stores as bodyfat, or **adipose tissue**. Excess fat is stored either subcutaneously (under the skin) or viscerally (between organs in the abdomen) via **lipogenesis**.

Lipogenesis usually happens under conditions of high energy and insulin levels. When both energy availability and insulin levels are low, **lipolysis** occurs to reverse the process, and stored fat is metabolized for energy.

Fats play an important role in hormone production, and nutritional intake of fat can affect several hormones and their downstream effects. For instance, nutritional lipids affect the synthesis of **prostaglandins** and **steroid hormones**, which are each a part of human reproduction. The body makes prostaglandins and steroid hormones from cholesterol and fatty acids in cells.

DID YOU KNOW:

Did you know one molecule of glucose produces 36 adenosine triphosphate (ATP) molecules? One molecule of palmitate (a fatty acid) can yield 129 ATP molecules through beta-oxidation in the mitochondria of cells. The end result is more energy than glucose, but the process of metabolizing the fatty acid to make ATP is slower and less efficient.

Fatty acids are found in higher concentrations within type-1 skeletal muscle, but the uptake is higher only if availability is higher. If an individual consumes more fat, muscle tissue will use it but not necessarily at an efficient rate.

ESSENTIAL FATTY ACIDS

Of the many lipids, only two are essential. Three others are considered important but are not strictly essential. They are sometimes referred to as “conditionally essential” because some people may need them due to disease or developmental conditions. **Essential fatty acids** cannot be produced in the body and must be supplemented or consumed as part of a balanced diet.

ESSENTIAL FATTY ACIDS:

Fats that cannot be produced in the body and must be supplemented or consumed as part of a balanced diet.

Some of the specific functions of essential fatty acids include the following:

- Maintaining the structure and function of cellular and subcellular membranes
- Serving as precursors for eicosanoids, which are important in regulating a wide diversity of physiological processes
- Transferring oxygen from the lungs through the alveolar membrane
- Maintaining proper brain and nervous system function
- Producing prostaglandins, a group of hormones important in inflammation and reproduction
- Forming healthy skin and hair
- Healing wounds and the inflammatory response

OMEGA-3 AND OMEGA-6

The omega acids are named for the chemical structure and the location of the final double bond. The first double bond is three carbons from the end of the omega tail for omega-3s and six carbons from the end of the tail for omega-6s. The groups of fatty acids simply categorize the types of lipids the body uses to function.

OMEGA-3 FATTY ACIDS:

A group of essential polyunsaturated fatty acids, including eicosapentaenoic acid, docosahexaenoic acid, and alpha-linolenic acid.

OMEGA-6 FATTY ACIDS:

A group of essential polyunsaturated fatty acids, including linoleic acid.

LINOLEIC ACID:

A common essential omega-6 fatty acid.

DID YOU KNOW:

Omega-3 fatty acids are considered anti-inflammatory while omega-6 fatty acids are considered pro-inflammatory.

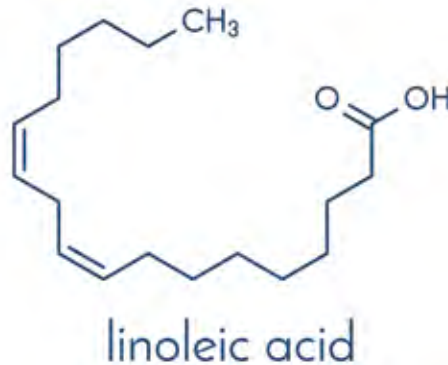
The **omega-3 fatty acids** are essential and play a critical role in human cell membranes on a microlevel. On a macrolevel, omega-3s have been found to support brain development, fight inflammation, improve bone density, and reduce liver fat.

The **omega-6 fatty acids** are also essential and primarily used for energy in the body. **Linoleic acid** is a common omega-6 and is often consumed in far greater quantities than the omega-3 fatty acids. Research has shown the ideal nutritional ratio of omega-6 to omega-3 should be 4:1, but the average Western intake averages closer to 16:1 due to extensive use of vegetable oils.

LINOLEIC ACID

Found in safflower, corn, and soybean oils, this polyunsaturated omega-6 fatty acid can help reduce adipose tissue deposits and improve immune function. It has a vital role in cell membrane fluidity and structure as well as cell signaling.

Figure 6.2 Linoleic Acid.



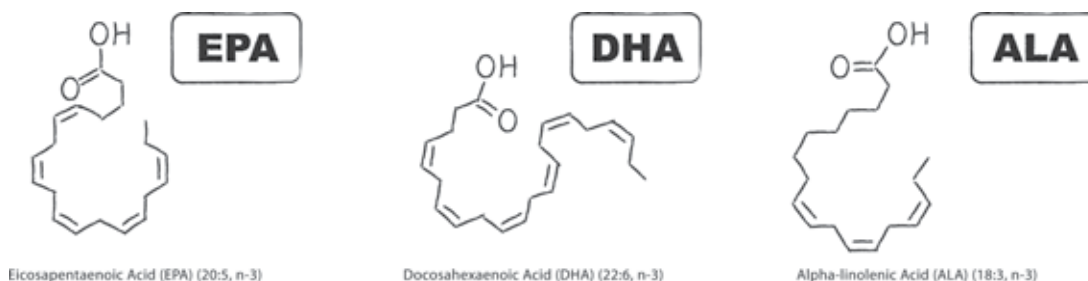
Excess linoleic acid in the body can cause inflammation, headaches, and lethargy, while deficiency can lead to skin and hair conditions like dermatitis and alopecia or developmental delays in children. It should be noted that deficiency is rare.

Linoleic acid is needed to synthesize another fatty acid, arachidonic acid. Arachidonic acid becomes essential only when there is a deficiency in linoleic acid. The presence of arachidonic acid in the diet has a sparing effect on linoleic acid.

ALPHA-LINOLENIC ACID

Alpha-linolenic acid (ALA), an omega-3 fatty acid, is the other essential fatty acid. It is also a polyunsaturated fat and is found in both animal products and some plant oils. ALA has several functions in the body, is important in growth, and is the precursor of two other important fatty acids: **eicosapentaenoic acid (EPA)** and **docosahexaenoic acid (DHA)**.

Figure 6.3 EPA, DHA, and ALA Structures.



The body uses the essential fatty acids for growth and functional needs over energy needs. A diet high in essential fatty acids and low in nonessential fatty acids increases metabolism and discourages bodyfat formation, assuming reasonable calorie consumption. Flaxseed oil, walnuts, chia seeds, fatty fish, and poultry are good sources of the essential fatty acids.

Research has shown that eating the right ratio of omega-6 and omega-3 fatty acids can help reduce systemic inflammation in the body. The recommendation for the nutritional omega-6 to omega-3 ratio is between 2:1 and 4:1. Most Americans eat far too few omega-3 fatty acids, resulting in a skewed ratio. The ratio for most Americans is between 11:1 and 30:1.

EPA AND DHA

As early as the 1950s, researchers found that EPA and DHA could lower cholesterol. Decades later experts realized just how important these fatty acids are after documenting low rates of cardiovascular diseases among Greenland natives. This population consumes high amounts of fatty fish with DHA and EPA.

EPA and DHA are omega-3 fatty acids but can be produced in the body from the essential fatty acid ALA, making them not technically essential. Despite this, adding them to a healthy diet can have benefits, especially for diets low in saturated fatty acids.

EPA and DHA disperse fatty acids and cholesterol in the bloodstream, which is thought to be how they reduce arterial clogging and cardiovascular disease. They have a blood-thinning effect and discourage blood clotting. EPA and DHA may also lower blood triglycerides and raise **high-density lipoprotein (HDL)** cholesterol levels.

ALPHA-LINOLENIC ACID (ALA):

An omega-3 fatty acid found to be effective for treating depression and anxiety.

EICOSAPENTAENOIC ACID (EPA):

An omega-3 fatty acid used to reduce triglyceride levels.

DOCOSAHEXAENOIC ACID (DHA):

An omega-3 fatty acid used to reduce chronic disease and functions in the development of the brain, skin, and eyes.

DID YOU KNOW:

Did you know flaxseed oil supplies a good source of ALA? Flaxseed oil contains about 51–57 percent ALA but also 15–18 percent linoleic acid. Using flaxseed oil as a substitute for cooking and for salad oils, butter, and margarine helps to increase essential fatty acids intake.

HIGH-DENSITY LIPOPROTEIN (HDL)::

The “good” cholesterol carrying LDL out of the bloodstream and to the liver, where it is broken down and excreted.

EPA and DHA exert an anti-inflammatory effect and work by competing with arachidonic acid, which forms proinflammatory compounds. Studies using two to four grams per day of EPA and DHA from supplements and fish have reported significant increases in strength and aerobic performance.

GAMMA LINOLENIC ACID (GLA):

A nonessential omega-6 fatty acid derived from linoleic acid.

GAMMA LINOLENIC ACID

Gamma linolenic acid (GLA) is another important fatty acid that can be made in the body from linoleic acid. GLA is an important precursor for the series 1 prostaglandins, a group of hormones preventing blood platelets from sticking together, controlling cholesterol formation, reducing inflammation, making insulin work better, improving nerve function, regulating calcium metabolism, and involving immune system functioning.

Eating foods or taking supplements high in GLA can benefit overall health. Consuming enough GLA without supplementation can be difficult, as it is not found in many foods. The major sources include evening primrose oil, borage oil, and black current oil.

NONESSENTIAL FATTY ACIDS

The nonessential fatty acids can be produced in the body. However, consuming additional amounts through food or supplementation has been found to be beneficial.

OMEGA-9 FATTY ACIDS:

Common nonessential monounsaturated fats.

OMEGA-9

The **omega-9 fatty acids** are not essential and are monounsaturated, meaning they have only one double bond. These are the most common fats found in cells and have been found to have metabolic benefits. Oleic acid is the most common of the omega-9s.

PHOSPHOLIPIDS:

A class of lipid made of glycerol, two fatty acids, and a phosphate unit; a major component of cell membranes.

PHOSPHOLIPIDS

Phospholipids differ from triglycerides in that they have two fatty acid groups and one phosphate group attached to a glycerol molecule. The glycerol is attracted to water, known as **hydrophilic**, while the fatty acid tails are repelled by water, or **hydrophobic**. Phospholipids are major structural lipids in all organisms and important components in all living cells. Along with proteins, phospholipids make up cell membranes and the membranes of subcellular organelles.

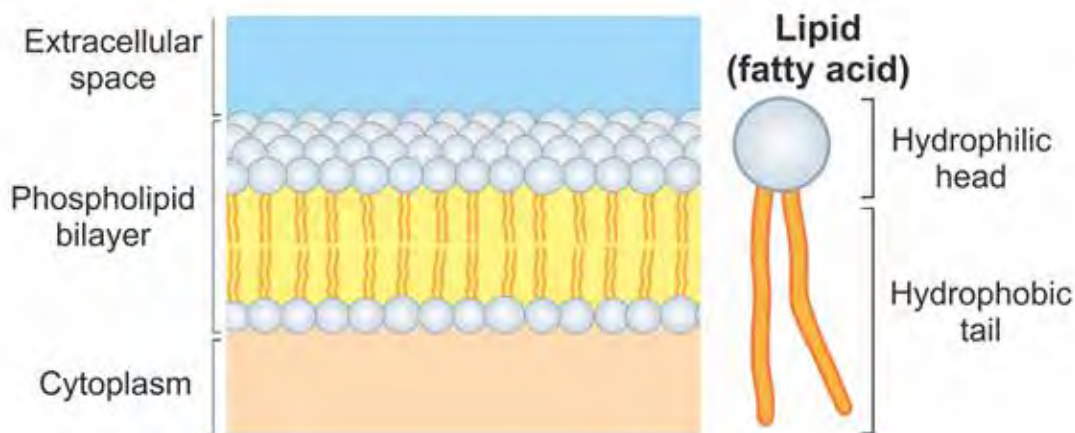
HYDROPHILIC:

Water loving.

HYDROPHOBIC:

Water repelling.

Figure 6.4 Phospholipid Structure.



The structure shown here is part of a cell membrane called the phospholipid bilayer.

The main function of phospholipids is the structural integrity of cell membranes. They also act as emulsifiers in the body. During digestion they disperse or package fats in water to be moved for metabolism. Phospholipids are important structural components of brain and nervous system tissue and of lipoproteins, which carry cholesterol and fats in the blood.

There are several types of phospholipids, but supplemental use has mainly focused on **lecithin (phosphatidylcholine)**. Lecithin supplies choline, which is essential for liver and brain function, and is found in egg yolk, liver, and soybeans. Lecithin's emulsifying properties may also remove fatty deposits from the blood.

Diets deficient in choline have been associated with memory impairment, leading to an increase in lecithin supplementation to promote brain health. Krill has become a popular supplement because it contains phospholipids as well as EPA and DHA. Choline is also important in creatine synthesis, so it may be beneficial in building strength.

Phosphatidylserine is another phospholipid-containing serine attached to the phosphate group comprising nearly 18 percent of the lipids in the cerebral cortex of the brain. Serine is an essential amino acid functioning in fat metabolism and is vital to the health of the immune system. Supplementation with 200–300 mg of phosphatidylserine has been associated with improved memory and learning. Up to 400–800 mg has been linked to a reduced level of cortisol as well as improved muscle growth and recovery after exercise.

LECITHIN (PHOSPHATIDYLCHOLINE):

A phospholipid with a choline group essential for liver and brain function.

PHOSPHATIDYLSERINE:

A phospholipid with the amino acid serine useful for improving memory and physical recovery.

STEROLS:

A group of naturally occurring unsaturated steroid alcohols.

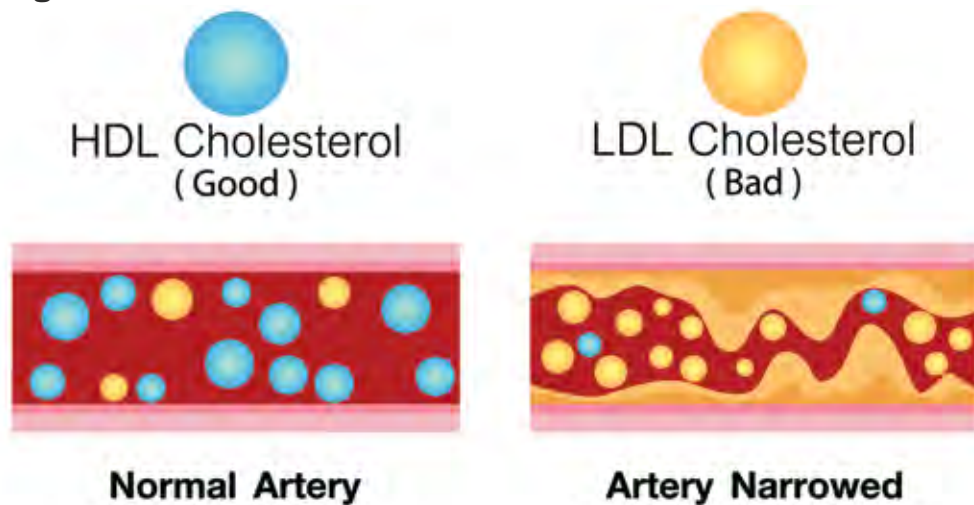
CHOLESTEROL

Cholesterol is a member of a group of lipids called **sterols** and is produced in the body. Nutritional cholesterol largely comes from animal products, although plants provide it in small quantities. Foods rich in cholesterol include liver, egg yolks, red meat, poultry (especially the skin), whole milk, and cheese.

Cholesterol is a component of all cells, a precursor of bile acids, a precursor of various sex and adrenal hormones, a precursor of vitamin D, and an important part of brain and nervous system tissues. There are two types of cholesterol: LDL and HDL. The HDL cholesterol is the beneficial type, while the LDL cholesterol can negatively affect the body.

The body needs a constant supply of HDL cholesterol for proper health and performance. The typical American diet is too rich in LDL cholesterol, with recommendations for optimal health keeping overall cholesterol intake under 300 mg per day. Individuals at risk for chronic health problems may be prescribed preventative nutrition plans with a severely restricted cholesterol intake.

Figure 6.5 HDL and LDL Cholesterol in Arteries.



Excess LDL can narrow arteries, leading to blood flow and heart issues.

CONJUGATED LINOLEIC ACID (CLA):

An isomer of linoleic acid derived from ruminant animals.

ISOMER:

Two or more compounds or molecules with the same formula but different atom arrangement.

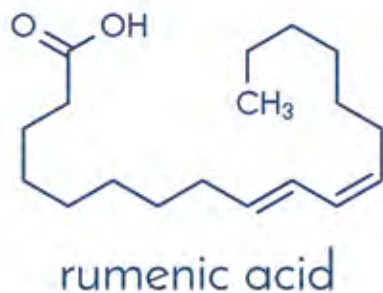
CONJUGATED:

A molecule formed by the union of two molecules with two double bonds separated by a single bond.

CONJUGATED LINOLEIC ACID

Conjugated linoleic acid (CLA) is an **isomer** of linoleic acid and is sometimes referred to as rumenic acid for its origin in ruminant animals. **Conjugated** means it is formed by the union of two molecules with two double bonds separated by a single bond.

Figure 6.6 Conjugated Linoleic Acid (Rumenic Acid).



ADIPOSITY:
Bodyfat stores.

CLA is a common lipid supplement marketed to reduce bodyfat stores, or **adiposity**, build muscle, and increase energy levels. While not essential, it is commonly supplemented due to its purported health benefits.

MEDIUM-CHAIN TRIGLYCERIDES

Medium-chain triglyceride (MCT) supplement formulations were first made in the 1950s using coconut oil. MCT is a group of triglycerides containing saturated fatty acids with chains of only 6–12 carbon atoms. MCT formulations are high in caprylic acid and capric acid, which are saturated fatty acids.

Originally created as calorie sources for people with conditions preventing digestion of long-chain fatty acids, MCTs behave differently in the body than fats with longer carbon chains in the following ways:

- MCTs dissolve more readily in water.
- They can pass from the intestines directly into the bloodstream. Fatty acids usually pass from the intestines first into the lymphatic system and then into the bloodstream.
- The body can digest MCTs more easily.
- Although they can be converted to bodyfat, MCTs are not readily stored in fat deposits and are quickly used for energy in the liver.
- They can also pass freely, without the aid of carnitine, into the mitochondria of cells.

All these qualities make MCTs a quick source of energy for the body, but it is important to remember that they are saturated fats. Experts recommend consuming no more than 10 percent of daily calories in the form of saturated fats because of their link with chronic disease.

MEDIUM-CHAIN TRIGLYCERIDE (MCT):
Triglyceride with shorter fatty acid chains containing just 6–12 carbon atoms used as a supplement for quick energy and certain medical conditions..

DID YOU KNOW:

Did you know in recent studies, some individuals who ingested only moderate amounts of MCTs developed elevated triglyceride and cholesterol blood levels? How much any individual can supplement with MCTs depends on several factors: their total saturated fat intake, sensitivity to saturated fat, and duration of use. If experimenting with MCTs, start slowly with low dosages, and use formulations that also contain EPA and DHA. This should be done under physician supervision to monitor detrimental health effects.

TRANS FATTY ACIDS:

Unsaturated fatty acids that have been hydrogenated or partially hydrogenated.

HYDROGENATION:

The process by which hydrogen atoms are added to unsaturated sites on fatty acids, converting double bonds to single bonds.

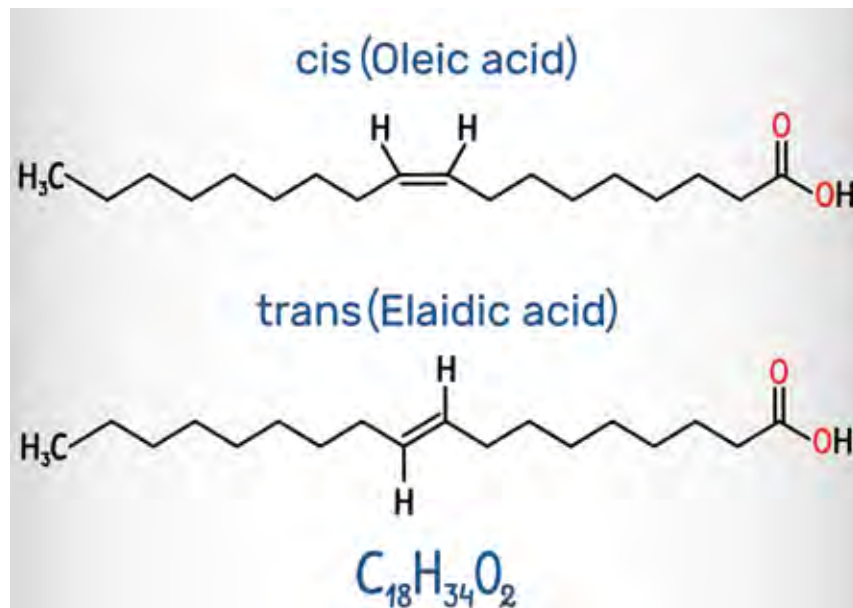
PARTIAL HYDROGENATION:

The hydrogenation of fatty acids resulting in the “trans” configuration.

TRANS FATTY ACIDS

Trans fatty acids, also known as trans fats, occur naturally in small amounts in some animal products and are produced synthetically by hydrogenating vegetable oils. **Hydrogenation** is the process by which hydrogen atoms are added to unsaturated sites on fatty acids, converting double bonds to single bonds. **Partial hydrogenation** relocates some double bonds, and hydrogen atoms end up on different sides of the fatty acid chain. This type of configuration is called trans, from the Latin word for “across.”

Figure 6.7 Cis and Trans.



The cis form is oleic acid. After partial hydrogenation, the trans form, elaidic acid, is produced.

Food manufacturers hydrogenate unsaturated vegetable oils to preserve them. The hydrogenation process transforms liquid oils to solid fats, which have a longer shelf life, and hydrogenated fats help packaged foods last longer.

Human studies demonstrated that consumption of trans fats leads to increases in LDL cholesterol and decreases in HDL cholesterol. Government regulations now require that food nutrition labels list the amount of trans fats. Some foods that often contain trans fats include baked goods, shortening, microwave popcorn, fried foods, margarine, and frozen or refrigerated dough.

DIGESTION OF FATS

The digestion of fats is a much more detailed process than the other macronutrients. Each segment of the digestive tract has a different role in packaging, absorbing, transporting, and storing fats in the body.

FROM THE MOUTH TO THE STOMACH

Fats first begin to break down in the mouth through chewing. The enzyme **lingual lipase** starts the process of digestion in saliva, using the amino acids aspartate, histidine, and serine to hydrolyze medium- and long-chain triglycerides, breaking them down into partial glycerides and free fatty acids. Saliva also acts as an **emulsifier**, dispersing tiny droplets of fat and separating them from the watery components.

In the stomach, **gastric lipase** breaks down triglycerides into diglycerides and fatty acids. The churning of the stomach during digestion also helps break down fats. Fatty acid digestion takes much longer than carbohydrate digestion, and only about 30 percent of triglycerides are broken down two to four hours after eating. Diglycerides act as emulsifiers to break down nutritional fats. However, fats must move farther down the digestive tract to be fully digested and absorbed.

ABSORPTION INTO THE BLOODSTREAM

There are four pathways for fatty acids to enter the bloodstream—exogenous, endogenous, reverse cholesterol transport, and ketogenesis.

Exogenous Pathway

Once stomach contents empty into the small intestine, bile is excreted to act as an emulsifier. Bile contains **bile salts**, lecithin, and derivatives of cholesterol. Emulsification increases the surface area of lipids by creating smaller droplets, making them more accessible to the digestive enzymes.

LINGUAL LIPASE:

An enzyme using amino acids aspartate, histidine, and serine to hydrolyze medium- and long-chain triglycerides, breaking them down into partial glycerides and free fatty acids.

EMULSIFIER:

A substance that disperses fat into smaller droplets as part of the digestion process.

GASTRIC LIPASE:

An enzyme secreted by cells in the stomach, breaking down and digesting fats.

BILE SALTS:

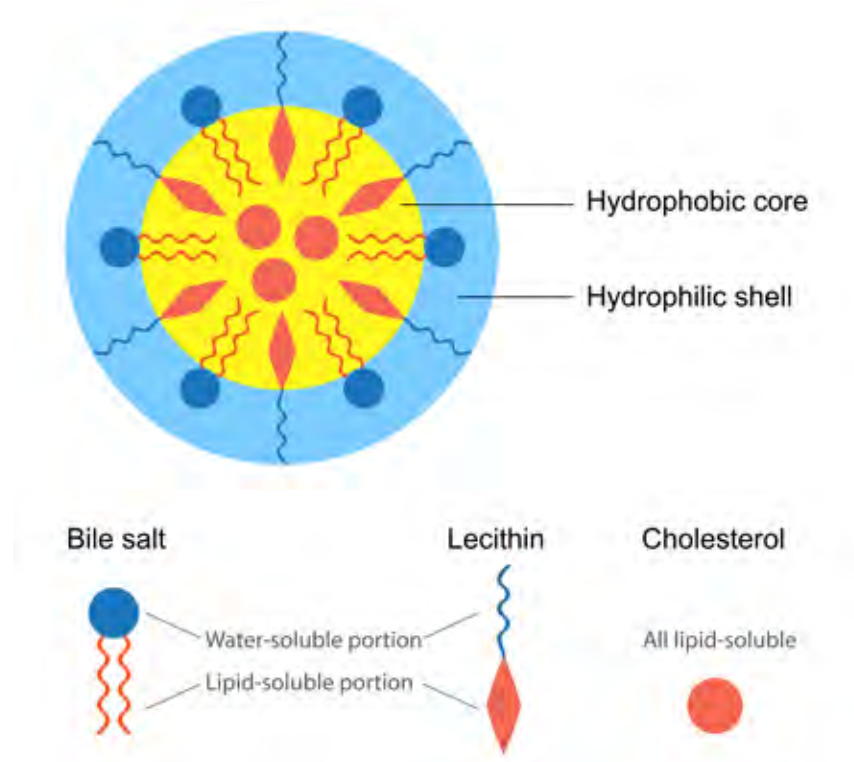
Bile acids produced in the liver and conjugated with the amino acids taurine or glycine that act to stabilize fats in the small intestines.

MICELLES:

Bile salts aiding in the transport through the small intestine that are released, without crossing the membrane, as the fatty acid is absorbed.

Next, pancreatic lipase mixes in the small intestine to break down fats into free fatty acids and monoglycerides by breaking the bond between the fatty acids and glycerol. Bile salts then cover the fatty acids and monoglycerides to make **micelles**, which have a fatty acid core and water-soluble exterior. This structure allows the molecule to move into the intestinal microvillus. Once in the cells, the fat components are released.

Figure 6.8 Structure of a Micelle.



LIPOPROTEINS:

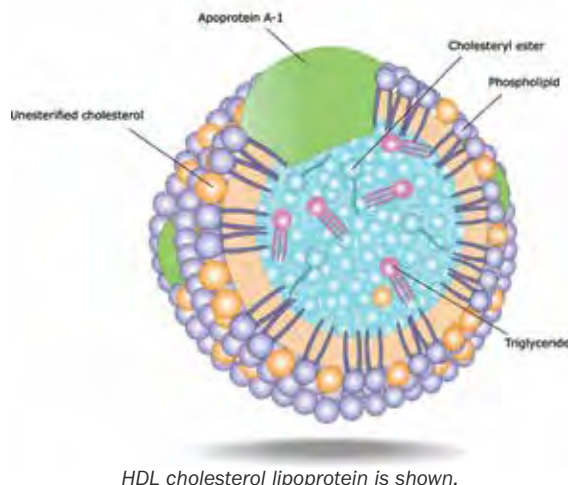
Proteins bound to fat to transport lipids through the bloodstream.

CHYLOMICRON:

A droplet of fat that has been absorbed through the small intestine into the bloodstream or lymphatic fluid.

When fatty acids move through the wall of the digestive tract, they reassemble into triglycerides. Triglycerides, cholesterol, and phospholipids join with protein carriers to form **lipoproteins**. A lipoprotein core is made of triglycerides and cholesterol esters (cholesterol bound to a fatty acid). The exterior of a lipoprotein is made of phospholipids interspersed with proteins and cholesterol. Many lipoproteins combine to form a **chylomicron**. Chylomicrons enter the lymphatic system to be released into the bloodstream via the jugular vein. They transport nutritional fat to the liver and other body tissues.

Figure 6.9 Structure of a Lipoprotein.



Once chylomicrons enter the bloodstream, lipoprotein lipase breaks down their fats. This shrinks the chylomicron, which then becomes a chylomicron remnant that goes back to the liver to be reabsorbed. Receptors in the liver bind to apolipoprotein E. These complexes are drawn into cells via endocytosis to be broken down by lysosomes.

Endogenous Pathway

When the body needs lipids or when liver stores are low, **cholesteryl esters** are converted to very low-density lipoprotein (VLDL) complexes and exported through this pathway. VLDL complexes contain the following lipoproteins:

- ApoB-100
- ApoC-I
- ApoC-II
- ApoC-III
- ApoE

VLDLs travel to the muscles and adipose tissue where ApoC-II activates lipoprotein lipase to break down the fat. In muscle cells, fatty acids are oxidized, whereas in adipocytes, fatty acids are reassembled into triglycerides and stored in fat droplets.

VLDLs shrink when fat is removed, first to intermediate-density lipoprotein complexes and then to LDL complexes.

CHOLESTERYL ESTERS:

Esters of cholesterol, a slightly different chemical form of cholesterol that is less soluble in water.

Reverse Cholesterol Transport

HDL cholesterol complexes are made in the liver and small intestine. When first made they contain little amount of lipid, and HDL must collect cholesterol from the blood and from remnants of other lipoprotein complexes. HDL complexes absorb cholesterol and grow larger before returning the collected cholesterol to the liver or to LDL molecules. It removes cholesterol from the bloodstream where it can harden arteries, which is why it is referred to as the “good” cholesterol.

DID YOU KNOW:

Did you know oxidative damage to LDL during the endogenous pathway can lead to the formation of atherosclerotic plaques? These plaques embed into the walls of the blood vessels, reducing the elasticity of blood vessels and narrowing them.

The recycling of cholesterol into chylomicrons in the digestive tract during the exogenous pathway increases serum levels of cholesterol. Eating more vegetables reduces the recycling of cholesterol because plant phytosterols compete with cholesterol for absorption, and more cholesterol is eliminated in the stool.

Ketogenesis

With adequate carbohydrate levels, the body’s main energy pathway is **glycogenolysis**. Gluconeogenesis is often used as well—for instance, during exercise. However, in some situations, the body’s energy production shifts to the ketogenic pathway. These situations include alcoholism, starvation, type 1 diabetes, high-fat diets, and low-carbohydrate diets.

The body constantly makes small amounts of ketone bodies (ketones), each producing about 22 ATP molecules for energy under normal conditions. **Ketogenesis** is the process of creating the ketone bodies acetone, acetoacetate, and beta-hydroxybutyrate through the breakdown of fatty acids. Ketone bodies are water soluble and easily transported and taken into cells for energy production.

Ketogenesis can be increased by hormones—cortisol, glucagon, and thyroid—by breaking down free fatty acids to make them available for the ketogenic pathway. Insulin, however, is the main ketogenesis-regulating hormone. When insulin levels are low, free fatty acid concentrations rise. The rate of free fatty acid metabolism increases, and more ketone bodies are produced.

GLYCOGENOLYSIS:

The process of breaking down glycogen into glucose molecules for energy.

KETOGENESIS:

The process of breaking down fatty acids to produce ketone bodies and used in certain circumstances for energy production.

DID YOU KNOW:

Did you know the type of fat consumed affects the body's fatty acid composition? Comparisons between vegetarians and meat eaters show that vegetarians have more unsaturated fatty acids in their cell membranes and other parts of the body. People who consume more saturated fats have more saturated fatty acids, which tend to be less stable. They are more susceptible to damage from free radicals and metabolic toxic waste products, meaning the body and cells made of more unsaturated fatty acids may be more resistant to certain cellular damage.

NUTRITIONAL SOURCES OF FATS

When choosing foods based on saturated and unsaturated fats, it is important to strike a balance. Plant foods are healthful because they are rich in unsaturated fats, whereas many animal products contain high levels of saturated fats, too much of which can be detrimental for health.

On the other hand, animal foods provide more complete, high-quality proteins than most plant foods. A balance must be maintained to minimize saturated fats and cholesterol from animal products while also benefitting from them as protein sources.

When eating foods rich in fats, the emphasis should be on those with more unsaturated fat and less saturated fat and cholesterol, such as these:

- Olives and olive oil
- Avocados
- Nuts
- Seeds

Fats to avoid or minimize include the following:

- Butter
- Bacon fat
- Cream
- Mayonnaise
- Full-fat dairy products
- Deep-fried foods

Table 6.1 Common Foods and Fat Content (per 100 grams).

Fat source	Grams of fat per 100 grams of source	Fat source	Grams of fat per 100 grams of source
Almonds	54 g	Grapes	Trace
Apple	Trace	Hamburger	10 g
Asparagus	Trace	Hard-boiled egg	11 g
Banana	Trace	Honey	Trace
Barbeque sauce	7 g	Human milk (breast milk)	4 g
Beef sirloin	21 g	Jelly	0 g
Beer	Trace	Lettuce	Trace
Bread (one slice)	1–2 g	Mango	Trace
Broccoli	Trace	Margarine	80 g
Butter	81 g	Mayonnaise	79 g
Cashews	47 g	Mustard	29 g
Celery	Trace	Onion	Trace
Cheddar cheese	34 g	Orange	Trace
Cheese pizza	12 g	Oysters (raw)	1 g
Cheesecake	35 g	Peanut butter	54 g
Chicken	7 g	Peanuts	34 g
Coconut	62 g	Pickles	Trace
Cod	1 g	Pineapple	Trace
Coffee	Trace	Pistachios	54 g
Crab	5 g	Plain yogurt	4 g
Cream cheese (plain)	47 g	Pork chop	19 g
Doughnut	16 g	Potato	Trace
Flounder	11 g	Prawns/shrimp	2 g
Goat milk	5 g	Raisins	Trace

Table 6.1 Common Foods and Fat Content (per 100 grams) - Continued.

Fat source	Grams of fat per 100 grams of source
Red wine	0 g
Rice	Trace
Salami (sliced)	45 g
Salmon	8 g
Scallops	1 g
Skim milk	Trace
Spinach	1 g
Sponge cake	27 g
Swiss cheese	29 g
Tuna	22 g
Turkey (roasted)	7 g
Vegetable oil	100 g
Vinegar	0 g
Walnuts	52 g
Whole milk	9 g

As with other areas of nutrition, health, and fitness, too much or too little of any one thing can be detrimental. And, of course, exact intake needs vary depending on individual health factors.

RECOMMENDED DIETARY ALLOWANCES

In the typical American diet, fat makes up as much as 45 percent of calories, which is too much. Each gram of fat contains more than twice the number of calories of a gram of either carbohydrate or protein. In direct comparison of high-fat and low-fat meal plans, even when the number of calories in each is the same, a high-fat meal plan leads to greater fat storage.

The American Heart Association recommends keeping fat calories to 30–35 percent of daily calorie intake. Staying closer to 20 percent is beneficial for weight loss and maintenance. The International Olympic Committee recommends following a meal plan with no less than 15–20 percent of fat for highly active individuals and athletes.

Table 6.2 Amounts of Fats Recommended Based on Daily Calorie Intake.

Total calories per day	15 percent		20 percent		25 percent		30 percent		35 percent	
	Calories	Grams	Calories	Grams	Calories	Grams	Calories	Grams	Calories	Grams
3,000	450	50	600	67	750	83	900	100	1,050	117
2,500	375	42	500	56	625	69	750	83	875	97
2,250	338	38	450	50	563	63	675	75	788	88
2,000	300	33	400	44	500	56	600	67	700	78
1,750	263	29	350	39	438	49	525	58	613	68
1,500	225	25	300	33	375	42	450	50	525	58

The main problems with fat intake are that most people get too much total fat, too much of the wrong kinds of fats, and an inadequate amount of the “good” fats. The general rules for any individual are to keep total fat intake around 30 percent of total daily calories depending on activity level, to maximize essential fatty acids and omega-3 fatty acids, and to minimize saturated fatty acids and cholesterol.

More specifically, there are also recommendations for the essential fatty acids. The essential fatty acid Recommended Daily Allowances are general, and there may be differences for special populations, including athletes. The following are the nutritional reference intakes as published by the National Academy of Medicine in 2006:

- **Linoleic acid:** 17 grams per day for men ages 19–50; 12 grams per day for women ages 19–50
- **Alpha-linolenic acid:** 1.6 grams per day for men ages 19–50; 1.1 grams per day for women ages 19–50





VITAMINS

LEARNING OBJECTIVES

- 1 | Define and describe fat-soluble and water-soluble vitamins.
- 2 | Discuss the main functions of each vitamin.
- 3 | Describe the benefits of vitamins for health and optimal physiological performance.
- 4 | List important food sources for vitamins.

VITAMINS:

Organic compounds that are essential for human growth, function, and development but are required in the diet as they are not made in the body at all or are made in inadequate amounts.

MICRONUTRIENTS:

Essential elements that an organism requires throughout the life cycle in various amounts for physiological functions and to maintain health.

FAT SOLUBLE:

The property of being able to dissolve in fats and lipids, allowing easy passage through a cell's lipid membranes.

Vitamins are **micronutrients** required in the diet for maintenance of good health, normal metabolic functioning, tissue and bone growth, recovery and healing, immunity, athletic performance, and much more.

Found in fruits, vegetables, grains, milk, and dairy, vitamins are organic compounds, which means they contain carbon atoms as part of their chemical structure. Vitamins are essential in the diet because the body does not make them or does not make them in adequate quantities. Specific guidelines created by nutrition experts list the amount of each vitamin necessary for daily intake. The requirements vary and are listed as micrograms (mcg), milligrams (mg), and International Units (IU). A deficiency of any one vitamin can cause specific symptoms and health problems.

VITAMIN CLASSIFICATIONS

Vitamins are organized and classified by how they are absorbed and stored in the body: through fat or water. The first vitamin discovered and isolated in 1911 was vitamin A. This naming scheme continued, with each subsequent vitamin discovered assigned a letter. They also have additional scientific or common names.

FAT-SOLUBLE VITAMINS

The **fat-soluble** vitamins include vitamin A, vitamin D, vitamin E, and vitamin K. They dissolve, or are soluble in, fats (lipids) and organic solvents. This property allows the fat-soluble vitamins to pass through cell membranes. They can be stored in large amounts in bodyfat and in the liver.

Because these vitamins are stored in adipose tissue, consuming them in excess can easily lead to toxicity. Vitamin toxicity is rare but possible, and the use of vitamin supplements makes it easier to exceed safe intake. It is important for nutrition coaches to understand the lower limits, recommended intake, and upper intake levels for vitamins when working with clients.

Digestion and absorption of the fat-soluble vitamins requires adequate fat in the diet. Individuals on low-fat and low-calorie diets must be aware of the potential for deficiency due to absorption issues. For fat-soluble vitamin supplements, use oil-based formulations to improve absorption, or take with a meal that includes fat.

VITAMIN A (RETINOL, BETA-CAROTENE)

Role in the Body

Vitamin A plays important roles in eye health and vision, the immune system, reproduction, and fetal development. Beta-carotene is the precursor to the usable form of vitamin A called retinol. The active form of vitamin A protects the cornea and conjunctiva of the eye and makes it possible for humans to see in color and in low light.

Carotenoids belong to a class of molecules with activities similar to vitamin A. They are also pigments that give red, orange, and yellow foods their distinctive colors. The body converts carotenoids to vitamin A and retinol. Beta-carotene is the most common carotenoid and has about one-sixth the biological vitamin activity of retinol. Other carotenoids with vitamin A activity include alpha-carotene and beta-cryptoxanthin. Carotenoids may have additional benefits beyond vitamin A activity, including **antioxidant** properties.

Deficiency Symptoms

Vitamin A deficiency causes dry skin or rash, frequent infections, and night blindness or impaired vision. In developing countries, **xerophthalmia**, or dryness and thickening of the cornea, is the most common symptom of vitamin A deficiency. Poor absorption of vitamin A, regardless of intake, increases the risk of developing celiac disease, chronic diarrhea, cirrhosis, and cystic fibrosis.

Toxicity Levels and Symptoms

Excess intake of vitamin A can occur acutely or chronically. Symptoms include nausea and vomiting, yellowed or severely dry skin, hair loss, bone pain, vision changes, and swelling of the bones. Chronic overdosing of vitamin A can lead to liver damage, excess calcium in the body, and osteoporosis.

Signs of toxicity in adults appear after prolonged daily intakes of 15,000 micrograms (50,000 IU) of retinol and 6,000 micrograms (20,000 IU) of retinol in children and infants. In women, ingestion of high therapeutic doses of vitamin A has been reported to cause spontaneous abortions and birth defects. Women who are pregnant, or planning to become pregnant, should consult their doctor to determine the proper dosage of vitamin A or any other supplement.

CAROTENOIDS:

The plant-based class of yellow, orange, or red fat-soluble pigments with vitamin A activity.

ANTIOXIDANT:

A substance that neutralizes damaging oxidizing compounds in the body.

XEROPHTHALMIA:

Dryness or thickening of the cornea.

Food Sources

Good sources of vitamin A include liver, fish liver oils, egg yolk, crab, halibut, whole milk products, butter, cream, margarine, and vitamin A–fortified milk. Beta-carotene can be found in carrots and green leafy vegetables, spinach, broccoli, squash, apricots, sweet potatoes, and cantaloupes.



Considerations for Athletes

While studies show that adequate intake of vitamin A and beta-carotene is important for overall health and performance, they do not support the use of megadoses for athletic improvement. Beta-carotene intake may be increased in proportion to activity levels for maximum antioxidant benefits.

Other Vitamin A Facts

The forms of vitamin A most common in supplements are vitamin A acetate and palmitate. These are effective and economical synthetic forms of retinol. Beta-carotene, which originates in plants, is typically a synthetic form in supplements. Both vitamin A and beta-carotene also come in gelcaps, capsules, and tablets. The dry forms tend to be more stable than those suspended in oils.

DID YOU KNOW:

Research into additional roles of nutrients beyond preventing deficiencies led to the identification of a group of vitamins, minerals, and enzymes called antioxidants. These are now known to play a role in protecting the body from chemical damage. Free radicals are compounds that damage biomolecules through a process called oxidation. This damage contributes to aging and a number of diseases, including cancer. Oxygen itself also causes cellular damage over time. Everyone is exposed to free radicals, so it is important to include antioxidant nutrients in a balanced diet.

Some common antioxidants or antioxidant cofactors include beta-carotene (vitamin A) and other carotenoids (phytonutrients from plants), vitamin C, vitamin E, cysteine, glutathione, selenium, bioflavonoids, polyphenols, proanthocyanidins, and super oxide dismutase.

VITAMIN D (CALCIFEROL)**Role in the Body**

Vitamin D has several important functions and is essential for normal growth and development. Its main function is the absorption and metabolism of calcium and phosphorus to support the mineralization, or hardening, of bones and teeth.

Vitamin D is involved in many aspects of calcium and phosphorus metabolism, including mediating intestinal absorption and use. Maintenance of the appropriate level of serum calcium promotes the proper functioning of the neuromuscular system and heart action. There is also some evidence that vitamin D improves muscle strength, maintains immune function, and reduces the risk of osteoporosis and is involved in the process of cell division.

Deficiency Symptoms

Vitamin D deficiency is characterized by inadequate mineralization of bone and associated abnormalities. These include soft bones, bowed legs, poor teeth, and skeletal deformities. In children, this deficiency can result in severe deformation of the skeleton, a condition known as rickets. Adults may experience loss of bone density and increased fractures. Vitamin D deficiencies are rarely seen today because many foods, like milk, are fortified. Rickets is of concern in infants who are breastfed without supplemental vitamin D or adequate exposure to sunlight. Characteristic biochemical changes include low blood calcium and phosphorus levels. Elderly people and persons who spend most of their time indoors should be aware of vitamin D levels and consider supplementation.

Toxicity Levels and Symptoms

Excess vitamin D intake can be harmful, especially for young children. The consequences include calcium build-up in soft tissues and irreversible kidney and cardiovascular damage. Harmful levels have not been clearly established; however, consumption of 100 mcg or more daily is considered overdosed. Sun exposure also leads to the formation of vitamin D in the body

Food Sources

Dietary sources of vitamin D include fish liver oil, eggs, butter, cream, halibut, herring, liver, mackerel, salmon, sardines, and shrimp. In the United States, foods fortified with vitamin D are a major dietary source, especially milk. Vitamin D formed by exposure to sunlight can also be a major contributing factor, making precise dietary guidelines difficult to determine. Anyone who limits sun exposure needs more vitamin D from dietary sources.



Considerations for Athletes

Studies have not supported any benefits for using megadose amounts of vitamin D to improve athletic performance.

VITAMIN E (ALPHA TOCOPHEROL)

Role in the Body

Vitamin E's major function is as an antioxidant that prevents free-radical reactions (oxidation) and protects fatty acids within cell membranes. Other functions include red blood cell formation and prostanoid synthesis. Prostanoid compounds are important in the reproductive process, blood platelet aggregation, energy metabolism, synthesis of DNA and RNA, aging, and the prevention of heart disease.

Vitamin E protects cell membranes against oxidation, inhibits coagulation of blood by preventing blood clots, retards oxidation of the other fat-soluble vitamins, participates in cellular respiration, and treats and prevents vitamin deficiency in premature or low-birth-weight infants.

Deficiency Symptoms

Vitamin E deficiencies have been clearly observed in animals but are less clear in humans. Newborn infants have a low tissue concentration of vitamin E. Hemolytic anemia and dermatitis have been seen particularly in premature infants with vitamin E deficiency. The infants may also have weakness, red blood cell rupture, and fatty deposits in muscle tissue.

Toxicity Levels and Symptoms

Potentially toxic intake of vitamin E is 1,000 mcg or more. Compared to the other fat-soluble vitamins, vitamin E is relatively nontoxic when orally ingested, but individual tolerances vary. High levels of vitamin E may interfere with the activity of vitamin K, leading to anticoagulant dysfunctions and delayed blood clotting.

Food Sources

Dietary sources of vitamin E vary significantly depending on storage and preparation. The richest sources are vegetable oils, such as soybean, corn, cottonseed, peanut, and safflower. Fortified products containing vitamin E include margarine, wheat germ, and nuts. Meat, fish, animal fats, and fruit are mostly low in vitamin E.



Considerations for Athletes

Some studies support increased intake of vitamin E by athletes. For athletes in high altitudes (over 5,000 feet above sea level), maintaining vitamin E intake at the upper end of the acceptable range during training and competition may prevent muscle cramps and counteract the higher levels of free radicals caused by increased activity levels. For the same reason, higher doses of vitamin E may help with recovery from injury or surgery.

BIOACTIVE:

Having a biological effect.

Other Vitamin E Facts

Both natural and synthetic forms of vitamin E can be supplemented. The natural form, d-alpha tocopheryl succinate, is better absorbed in the body. Other **bioactive** forms include alpha-tocopherol and alpha-tocopheryl acetate. Vitamin E is found in gelcaps, in oil, or as a solid. All delivery systems are effective, but the dry form is more stable.

VITAMIN K (PHYLLOQUINONE, MENAQUINONE, MENADIONE)

Role in the Body

Vitamin K is a **coenzyme**. It promotes the formation of prothrombin and procoagulants. It is vital for blood clotting and coagulation. Vitamin K is also involved in the maintenance of bone tissue.

COENZYME:

A nonprotein compound required for the functioning of an enzyme in the body.

Deficiency Symptoms

Vitamin K deficiency is rare in healthy individuals eating a balanced diet. However, deficiency can develop if green vegetables are restricted from the diet or drugs are taken that inhibit the formation of vitamin K by intestinal bacteria. Most cases of vitamin K deficiency are in infants.

Excessive doses of aspirin can interfere with the vitamin K–assisted metabolic pathways and prevent normal blood clotting. Vitamin E can also inhibit vitamin K in large doses. A deficiency of vitamin K lowers prothrombin levels and increases the risk of a hemorrhage. Vitamin K may be given intravenously to patients before surgery to aid in blood clotting.

Toxicity Levels and Symptoms

No toxic side effects have yet been observed with excessive intake of vitamin K in adults, even over long time periods. Excessive dosages in lab animals and in infants have been shown to cause hemolytic anemia, a separation of the hemoglobin from red blood cells.

Food Sources

The main dietary sources of vitamin K are green leafy vegetables. Small amounts are found in milk and dairy products, eggs, cereals, fruits, and vegetables. Another source of vitamin K is intestinal bacteria, which make the compound. It is still unclear how much this contributes to overall vitamin K levels and if it can be considered a major source.



Considerations for Athletes

There have been few studies conducted on vitamin K's direct effects on performance.

Other Vitamin K Facts

There are several compounds that display vitamin K activity. Phylloquinone (vitamin K₁) is the principal one. Other forms of vitamin K include menaquinone (vitamin K₂), which is produced by intestinal bacteria, and menadione (vitamin K₃), which is a synthetically produced form of vitamin K. Phylloquinone occurs naturally in green plants. Menaquinone is formed in the intestines as a byproduct of bacterial metabolism. The synthetic form of vitamin K, menadione, is about twice as potent as the naturally occurring phylloquinone form.

DID YOU KNOW:

Did You Know? There are many vitamin-like compounds that the body uses for physiological functions and to prevent inflammation and infection. They are classified separately from vitamins, minerals, proteins, fats, and carbohydrates and have important proven health benefits. These nutrients can be found in a balanced diet with a focus on whole plant-based foods and animal proteins. Examples include the following:

Zoonutrients

Zoonutrients are found in animals and have anti-inflammatory, antimicrobial, and antihypertensive properties. They may also support the bacterial biome in the digestive tract. Zoonutrients include omega-3 fatty acids from fatty fish and conjugated linoleic acid (CLA) derived from beef proteins.

Phytochemicals

Phytochemicals also prevent inflammation and work as antioxidants in the body. The root word phyto means “plant.” These compounds come from plants and include flavonoids. Flavonoids give plants and fruits their vibrant colors and can be found in wines, berries, spices, and beans.

Myconutrients

The root word myco means “mushroom” or “fungus.” Myconutrients are derived from edible mushrooms of all types. Research has found that edible fungi have anti-inflammatory properties and can boost immune function. Common varieties of edible mushrooms include button, chanterelle, shiitake, oyster, and portobello.

WATER-SOLUBLE VITAMINS

Water-soluble vitamins include vitamin C and the family of B vitamins. These vitamins are not stored in the body in significant amounts because they dissolve in water and are excreted in urine. Regular daily intake is required to avoid deficiency and interference with normal metabolic functions. The B vitamins act as coenzymes and are involved in the metabolism of fats, proteins, and carbohydrates. Vitamin C is an antioxidant and boosts the immune system.

WATER SOLUBLE:

The property of being able to dissolve in water, allowing excess to be excreted from the body as waste.

VITAMIN C (ASCORBIC ACID)

Role in the Body

Vitamin C serves multiple roles as a cofactor or coenzyme. It is involved in the formation and maintenance of collagen, which is an important constituent of connective tissues. Collagen is a protein and an important component of skin, ligaments, and bones.

Vitamin C plays several roles in the body:

- Promotes healthy capillaries, gums, and teeth
- Aids in intestinal iron absorption, transport, and storage
- Prevents the oxidation of folacin
- Helps heal wounds
- May provide resistance against infections
- Aids in the metabolism of tyrosine and phenylalanine
- Boosts immune function
- Protects cells from free radical damage

Studies also show that vitamin C may be involved in increasing muscular strength, reducing lactate blood levels, and sparing glycogen.

Deficiency Symptoms

A deficiency in vitamin C can lead to scurvy, which is a serious disease characterized by weakening of connective tissues. This results in capillary hemorrhaging. Scurvy is rarely seen in adults in the United States, but it is sometimes observed in infants and the elderly.

Toxicity Levels and Symptoms

More than two grams of vitamin C per day has been associated with several potential side effects, including headache, increased urination, diarrhea, and nausea. Megadosing vitamin C is sometimes used to prevent the common cold. As with all vitamins, megadosing many times above the recommended levels for extended periods of time is risky.

Food Sources

Dietary sources of vitamin C include fruits and vegetables, especially citrus fruits, green and red peppers, collard greens, broccoli, spinach, tomatoes, potatoes, and strawberries.



Considerations for Athletes

There may be performance benefits for increasing vitamin C intake with increasing activity. Endurance athletes may need higher amounts of antioxidants for optimal performance.

Other Vitamin C Facts

The primary form of vitamin C used in supplements is ascorbic acid, a synthetic product. Other forms include buffered vitamin C and mineral ascorbates, such as calcium and magnesium ascorbate. A natural supplemental form of vitamin C comes from rose hips, which is more expensive than synthetic supplements. Bioflavonoids may increase vitamin C absorption. A patented form of vitamin C is Ester-C. The company that manufactures it ran independent studies with some evidence that it may be more bioavailable than other forms of vitamin C.

VITAMIN B1 (THIAMIN)

Role in the Body

Thiamin is converted into coenzymes that aid in the breakdown of carbohydrates and branched-chain amino acids. Other functions of thiamin include the production of ribose, which is needed for the synthesis of nucleic acids (RNA and DNA), for normal growth and cellular function, and for appetite stimulation.

Deficiency Symptoms

Signs of vitamin B₁ deficiency include abnormalities of carbohydrate metabolism, fatigue, loss of appetite, constipation, depression, confusion, poor coordination, and a disease called beriberi. Beriberi affects the heart and the circulatory system and can cause heart failure. Thiamin deficiency can be triggered by excessive alcohol consumption.

Toxicity Levels and Symptoms

Excessive intakes of thiamin are cleared by the kidneys. Thiamin toxicity is rarely reported in healthy adults, and there is no established unsafe amount to supplement.

Food Sources

Dietary sources of thiamin include brewer's yeast, peas, pork, wheat germ, whole grain pasta, peanuts, beans, organ meats, and enriched and fortified grains and cereals.



Considerations for Athletes

Research indicates that endurance athletes may derive acute performance-enhancing effects with megadoses of thiamin for three to five days before a competition. However, more research is needed to conclusively verify these effects and determine the amount that is both effective and safe.

VITAMIN B2 (RIBOFLAVIN)

Role in the Body

Riboflavin is a coenzyme involved in energy production and cellular respiration. It functions primarily as part of two coenzymes: flavin mononucleotide and flavin adenine dinucleotide. These coenzymes are involved in many oxidation-reduction reactions that produce energy from carbohydrates, fatty acids, and some amino acids. Because of riboflavin's role in energy-producing reactions, it is a vital nutrient for the health of all tissues, particularly the skin, eyes, and nerves. It aids in energy production, tissue formation, maintenance of red blood cells, and the metabolism of iron and other nutrients.

Deficiency Symptoms

Deficiency symptoms of riboflavin include inflamed lips, cracked and dry skin, growth reduction, hair loss, cataracts, generalized seborrheic dermatitis, and behavioral changes such as depression, moodiness, nervousness, and irritability. Riboflavin is also essential to the functioning of vitamins B₆ and niacin. Some symptoms attributed to riboflavin deficiency are caused by the reduced functioning of these other vitamins.

Toxicity Levels and Symptoms

No identified unsafe amount exists for vitamin B₂, but extreme riboflavin intake can cause liver damage.

Food Sources

Dietary sources of riboflavin include brewer's yeast, meats, poultry, fish, dairy products, nuts, enriched grain products, green vegetables, broccoli, asparagus, spinach, turnip greens, wheat germ, kidney, and liver.



Considerations for Athletes

Megadosing with riboflavin is not recommended as there is no evidence it supports or enhances performance.

VITAMIN B3 (NIACIN)

Role in the Body

Niacin is functionally active in the body as two important coenzymes: nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP). NAD and NADP are present in all cells and function in vital metabolic processes, such as energy production, glycolysis, carbohydrate and protein metabolism, fatty acid synthesis, and steroid synthesis. Niacin also plays a role in reducing cholesterol and fatty acids in the blood.

Deficiency Symptoms

Deficiency symptoms of niacin include depression, confusion, headaches, elevated bodyfats, fatigue, and pellagra. Pellagra is a disease characterized by dermatitis, inflammation of mucus membranes, dementia, and inflamed and discolored skin.

Toxicity Levels and Symptoms

Niacin taken in amounts over 50 mg causes the blood capillaries to dilate, resulting in skin flushing, red skin, itching, and warmth. For this reason, the recommended daily limit is 35 mg.

Food Sources

Dietary sources of niacin include liver, brewer's yeast, lean meats, whole grains, nuts, legumes, and potatoes.



Considerations for Athletes

Excessive niacin intake may impair athletic performance. Although niacin is essential for cellular respiration and energy production, research has shown that it may reduce athletic performance. In studies with athletes, higher amounts of niacin given before exercise increased glycogen depletion and caused earlier onset of fatigue. Niacin blocks the release of fatty acids from adipose tissue, making it less available as a source of energy during exercise. Niacin megadosing should be avoided by endurance athletes.

On the other hand, there is some evidence that high dosages of niacinamide (an alternative form of niacin) given before anaerobic exercise may improve performance due to glycogen liberation and more anaerobic energy. More research is needed.

VITAMIN B6 (PYRIDOXINE)

Role in the Body

SPHINGOID BASES:

Signaling lipids found in animals and plants.

Vitamin B₆ plays a role in the metabolism of amino acids, glycogen, and **sphingoid bases**. Vitamin B₆ occurs in nature as pyridoxine, pyridoxal, and pyridoxamine. In the body, these are converted to the active forms pyridoxal phosphate and pyridoxamine phosphate. Because of the vitamin's role in amino acid metabolism, vitamin B₆ intake needs increase with protein intake. Vitamin B₆ is also involved in conversion of linoleic acid to arachidonic acid and in glycogen breakdown, energy production, tissue formation, and synthesis of red blood cells.

Deficiency Symptoms

Deficiency symptoms associated with vitamin B₆ include depression, skin problems, poor wound healing, anemia, fatigue, peripheral neuropathy, and convulsive seizures.

Toxicity Levels and Symptoms

Taking more than 1,000 mg of vitamin B₆ daily can cause skin lesions, gastrointestinal distress, lack of muscle control, numbness, and light sensitivity. Even smaller amounts, between 100 and 300 mg, may trigger some of these symptoms.

Food Sources

Dietary sources of vitamin B₆ include chicken, fish, kidney, liver, eggs, rice, soybeans, bananas, lima beans, peanuts, and walnuts.



Considerations for Athletes

Studies of megadosing B_6 show similar results as seen with niacin. Endurance athletes should avoid high dosages of vitamin B_6 .

Short-term anaerobic activity may benefit from extra B_6 due to the glycogen-liberating action that is also seen with niacin. In sports such as weight lifting and sprinting, the primary energy source is glycogen. Extra B_6 may promote greater glycogen use and result in higher power output. Strength and power athletes consume more protein, which increases B_6 requirements. Athletes undergoing glycogen depletion as part of a carbohydrate-loading program may expect more rapid depletion of glycogen stores with as little as eight milligrams of B_6 per day, but individual requirements and responses need to be determined. Vitamin B_6 intake has also been reported to increase the exercise-induced rise in growth hormone, which is another potential benefit for strength athletes.

VITAMIN B9 (FOLATE)

Role in the Body

Folate is involved in amino acid metabolism and nucleic acid synthesis. It is an essential cofactor in DNA and RNA formation, protein synthesis, and cell division. Folate also stimulates the formation of red blood cells and vitamin B_{12} . Folate affects tissues that grow rapidly, such as the skin, lining of the gastrointestinal tract, bone marrow where blood cells are formed, and regenerating muscle tissue. Studies indicate that increased folate intake during pregnancy reduces the risk of premature birth and birth defects. Folate supports early development of the fetal brain and spinal cord.

Deficiency Symptoms

Deficiency of folate can result in anemia, birth defects, sore tongue, digestive problems, growth problems, fatigue, poor memory, and megaloblastic anemia.

Toxicity Levels and Symptoms

Excessive folate intake, above 1,000 mcg daily, may cause kidney damage and stimulate seizures in anyone with epilepsy. It may also block zinc absorption.

Food Sources

Dietary sources of folate include beef, lamb, pork, chicken liver, eggs, asparagus, whole wheat, dark-green leafy vegetables, salmon, and yeast.



Considerations for Athletes

Endurance athletes can benefit from folate's role in red blood cell production and tissue repair. Speeding muscle tissue repair helps to minimize the stress of high-intensity or long-duration training. An additional 200 mcg daily has been shown to provide this benefit.

Considerations for Athletes

Female athletes may perform better with higher levels of B₁₂. While no additional dosing is recommended, it is generally not harmful. Research has shown that athletes with poor absorption of B₁₂ may see decreased performance in high-intensity activities.

VITAMIN B7 (BIOTIN)

Role in the Body

Biotin functions as a coenzyme in bicarbonate-dependent carboxylation reactions. It is involved in energy metabolism, urea formation, protein synthesis, and the metabolism of amino acids, glucose, and fatty acids. Biotin plays an important role in energy production and fat metabolism. It functions in the biosynthesis of fatty acids, replenishment of tricarboxylic acid cycle, amino acid metabolism and gluconeogenesis and as a coenzyme for a number of carboxylase enzymes. B₇ also helps to maintain cognitive function and healthy nail, hair, skin, and mucous membranes. It can be manufactured by intestinal bacteria as well as absorbed from dietary and supplemental sources.

Deficiency Symptoms

A biotin deficiency can be the result of low levels in the diet but also of excessive consumption of egg whites. A glycoprotein in egg whites binds with biotin, preventing its absorption. The risk of deficiency is higher with raw egg whites. Biotin deficiency causes nausea, vomiting, depression, pallor, dry scaly dermatitis, increased serum cholesterol, and loss of muscle tone.

Toxicity Levels and Symptoms

A common reaction to too much biotin in the body is a skin rash. There is no established unsafe amount of biotin.

Food Sources

Dietary sources of biotin include liver, egg yolk, soy flour, cereals, yeast, nuts, cauliflower, milk, and legumes.



Considerations for Athletes

Vitamin B₇ plays an important role in cellular energy production, which makes it of interest for athletes. However, no performance benefits have yet been seen with megadoses of biotin.

VITAMIN B5 (PANTOTHENIC ACID)

Role in the Body

Pantothenic acid plays many important metabolic roles, primarily as a component of coenzyme A (CoA). These metabolic reactions help produce energy from carbohydrates and fatty acids. Pantothenic acid is also involved in steroid and cholesterol synthesis and in the formation of tissue, membrane phospholipids, amino acids, and neurotransmitters.

Deficiency Symptoms

Deficiency symptoms of pantothenic acid include weakness, irritability, burning feet, vomiting, and insomnia. Deficiency is rare.

Toxicity Levels and Symptoms

The symptoms of toxicity are very rare and begin only at doses over 10 to 20 grams daily. Signs include heartburn, nausea, joint pain, and calcification of blood vessels.

Food Sources

Dietary sources of pantothenic acid include potatoes, eggs, pork, beef, fish, milk, whole wheat, whole grain cereals, fruits, and vegetables.



Considerations for Athletes

Megadosing pantothenic acid may be beneficial for endurance athletes for short time periods (7 to 14 days) before an athletic competition. This should be done only on an individual basis and under physician supervision.

VITAMIN-LIKE COMPOUNDS

Vitamin-like compounds are classified as neither fat soluble nor water soluble. They are nevertheless important compounds in cellular metabolism and body processes. They are essential nutrients worth noting and come from a variety of sources.

CHOLINE

Role in the Body

Choline is involved in fatty acid metabolism, liver function, and structural integrity of cell membranes. The term *lipotropic* is used to describe the effects of choline and other substances that prevent deposition of fat in the liver. Choline is a component of the phospholipid, phosphatidylcholine (lecithin), and a part of all cell membranes and lipoproteins. Choline is also used by the body to make the neurotransmitter acetylcholine, which is critical for optimal functioning of the nervous system. Exercise can deplete the supply of choline and may decrease acetylcholine Levels.

Deficiency Symptoms

Though not commonly observed, choline deficiency interferes with the liver, memory, nerve functioning, muscle functioning and recovery, and normal growth.

Toxicity Levels and Symptoms

Intake of two or more grams per day of choline may cause diarrhea, depression, and dizziness.

Food Sources

Dietary sources of choline include lecithin, egg yolk, liver, soybeans, most fatty foods, meat, whole grains, asparagus, green beans, spinach, and wheat germ.

Considerations for Athletes

Some research suggests that endurance athletes who supplement with choline have delayed muscle fatigue and shorter muscle recovery times after hard training. Doses ranged from one to two grams 30 to 60 minutes before training. Some researchers believe the performance benefits may be a result of correcting choline deficiency rather than from extra choline in the body.

VITAMIN B8 (INOSITOL)

Role in the Body

Like choline, inositol is a lipotropic agent. It is a carbohydrate found naturally in the body. It plays a role in fatty acid metabolism, carbohydrate metabolism, and intracellular calcium mobilization. It is also involved in the production of neurotransmitters and in glucose metabolism. The average American adult diet naturally contains about one gram of inositol per day.

Deficiency Symptoms

Deficiency in inositol causes a buildup of fat in the liver and may affect nervous system function. True deficiency of inositol is rare. Deficiency symptoms may be a result of reduced absorption or increased excretion.

Toxicity Levels and Symptoms

Studies have shown gastric upset (nausea, vomiting, gas, and diarrhea) in people treated with 12 grams of inositol per day or more.

Food Sources

Dietary sources of inositol include heart, organ meat, whole grains, fruit, milk, nuts, meats, and vegetables.

Considerations for Athletes

Inositol is naturally found in cell membranes in the body, and no benefit has been shown for athletes that megadose. More research is needed to determine if the compound's neurotransmitter benefits are helpful for athletic performance.

DIETARY GUIDELINES FOR VITAMINS

Traditionally, nutrient requirements are focused on the minimum amounts needed to prevent deficiencies. This is a “nutrition for survival” approach. New research indicates that greater amounts of vitamins can offer additional health benefits.

However, more is not always better. In addition to guidelines for the minimum amount needed for good health, there are also values for upper intake level. This is the highest amount of a nutrient in the diet that does not cause adverse health effects. Going over that limit poses health risks.

The reference table below is for educational purposes only. The data are derived from several reputable sources, including the US Food and Drug Administration and the Food and Nutrition Board of the National Academies of Sciences, Engineering, and Medicine, but individual needs vary. A personalization of vitamin intake for each client requires doctor supervision and testing for deficiencies or excesses that need correcting.

DID YOU KNOW:

Vitamin absorption rates vary depending on several factors.

Age: The body's ability to absorb and use vitamins varies with age. For example, vitamin C needs increase as children get older. Older adults need more vitamin B₁₂ and vitamin D because the ability to produce these compounds declines with age.

Gender: Women require higher levels of calcium, vitamin D, folate, and the B vitamins—especially pregnant and lactating women, as these vitamins are vital for fetal development.

On the contrary, men generally need less iron but more vitamin E to lower their risk of and prevent heart disease, which is more prevalent in men.

Medications: A nutrition coach must remain aware and up to date on the medications that a client is taking. Some medications can affect nutrient and vitamin absorption. Medications may be contraindicated with specific vitamins or supplements because of the potential for interactions that cause side effects or illness. Note that it is not in the scope of a nutrition coach to know all contraindications. Pharmacists are responsible for notifying clients of potential harmful interactions.

Athletes: There is no evidence to indicate that athletes need higher levels of vitamins than anyone else. It may be beneficial for an active individual to supplement specific vitamins based on their role in metabolism or recovery, but these are simply suggestions.

Hydration levels: Water is used in every biological process in the body. Dehydration can slow the metabolic processes in the body and reduce the capacity to absorb and use nutrients and vitamins. Dehydration also slows down waste elimination, which may lead to the excess buildup of vitamins in the body, potentially causing toxicity.

Daily Vitamin Intake Reference Information Summary (for Educational Purposes Only)			
USA Minimum and Upper Vitamin Reference Intakes (total intake from food and supplements)			
	Dietary Reference Intake (DRI)* Men Total Intake	Dietary Reference Intake (DRI)* Women Total Intake	Tolerable Upper Intake Total Intake
Vitamin A (Retinol)	900 mcg (3,000 IU)	700 mcg (2,330 IU)	3,000 mcg 10,000 IU
Vitamin C	90 mg	75 mg	2 g
Vitamin C	90 mg	75 mg	2,000 mg
Vitamin D	15 mcg 600 IU	15 mcg 600 IU	100 mcg 4,000 IU
Vitamin E	15 mg	15 mg	1,000 mg
Vitamin K	120 mcg	90 mcg	Not established
Thiamin	1.2 mg	1.1 mg	Not established
Riboflavin	2.5 mg	1.18 mg	Not established
Niacin	16 mg	14 mg	50 mg
Vitamin B6	2 mg	1.5 mg	100 mg
Folate	400 mcg	400 mcg	1,000 mcg
Vitamin B12	5 mcg	6 mcg	Not established
Pantothenic Acid	4 mg	4 mg	Not established
Biotin	30 mcg	30 mcg	Not established
Choline	550 mg	425 mg	3.5 g
Inositol	Not established	Not established	Not established
<p>Vitamin intake reference information is for total per day nutrient intake from conventional foods and dietary supplement sources, unless otherwise noted.</p> <p>mg = milligrams, mcg = micrograms, g = grams.</p> <p>Note: This information is for educational purposes only.</p> <p>* = highest DRI reported on a gender basis, excluding pregnant or lactating women.</p> <p>DRI includes Recommended Dietary Allowances (RDA) and Adequate Intakes (AI).</p> <p>References: Institute of Medicine, Dietary Reference Intakes: <i>The Essential Guide to Nutrient Requirements</i> (2006); <i>Vitamin and Mineral Safety</i>, 3rd ed. (Washington, DC: Council for Responsible Nutrition, 2014).</p>			



MINERALS

LEARNING OBJECTIVES

- 1 | Understand the classifications of minerals.
- 2 | Discuss the main physiological functions of each mineral.
- 3 | Discuss the health benefits of each mineral.
- 4 | Understand recommended intake and sources of each mineral.

MINERALS:

inorganic elements required for various physiological functions.

MAJOR MINERALS:

Minerals the body requires in relatively large amounts.

MINOR MINERALS:

Minerals the body requires in relatively small amounts.

ELECTROLYTES:

Minerals carrying an electric charge. Cations carry a positive charge (more protons than electrons), and anions carry a negative charge (more electrons than protons).

ORGANIC:

compounds containing carbon.

INORGANIC:

Compounds lacking carbon.

Minerals have long been regarded as essential nutrients for proper health and vigor.

Minerals are inorganic elements that are required for various physiological functions and are commonly categorized as major minerals (or macrominerals), minor minerals (or trace minerals), and electrolytes. **Major minerals** are required in relatively larger amounts, while **minor minerals** require a lower daily intake. **Electrolytes** are a classification of minerals with the specific ability to carry an electric charge. All minerals and the electrolytes are considered micronutrients on a larger nutritional scale.

Food and supplement sources of minerals are supplied either as **organic**, carbon-containing compounds or **inorganic** compounds. While minerals are found throughout the body, they are estimated to make up only about 4–6 percent of tissue. They are found in the body as components of tissues, like muscle and bone, as well as essential pieces of cellular metabolic processes and immune responses.

DID YOU KNOW:

Did you know organic minerals are alive (or were once living) and contain carbon? These compounds are readily broken down and used in the body and promote cellular metabolism and reproduction. Inorganic minerals were never alive. Inorganic minerals are often filtered out of things ingested and cannot be easily broken down inside the body and are, therefore, treated as toxins in excessive quantities.

- Organic: carbon dioxide, carbonates, and carbides.
- Inorganic: salts and metals.

Daily mineral requirements are directly correlated to activity levels as well as body size and lean body mass. Highly active individuals will sweat more and secrete larger amounts of minerals and electrolytes. Larger adults and those with larger amounts of lean body mass will also require higher daily intake of minerals to account for larger amounts of bone and muscle tissue.

BIOAVAILABLE:

The amount of a substance digested and entering circulation that has an active effect in the body.

Nutritional sources of minerals and electrolytes are the most effective for absorption and digestion in most people. In food, they are generally more **bioavailable**. However, supplementation is common whether from a general multivitamin or as individual supplements based on need. Some research has determined that supplementation is not generally necessary if a person's daily nutritional intake is well rounded and balanced.

MAJOR MINERALS

CALCIUM

Role in the Body

The adult body contains approximately 1,200 grams of calcium, 99 percent of which is present in bones as a calcium phosphate molecule. Calcium also occurs in the body in its free ionic state and as calcium carbonate. Calcium has essential roles in bone building and strength, transmission of nerve impulses, maintaining a regular heartbeat, muscle contraction, cellular membrane permeability, and blood clotting. Calcium also functions as an **enzyme cofactor** and has been connected to controlling blood pressure in some individuals. Vitamin D, copper, zinc, manganese, and boron are essential for proper use of calcium in the body, and the processes of bone turnover and kidney and intestinal absorption regulate its uptake.

Mineralization of bone requires a positive calcium balance—more calcium absorbed than excreted. Studies have shown that, aside from additional calcium supplementation and nutritional intake, consistent exercise can prevent bone loss and osteoporosis in older adults. Specifically, strength training and high-intensity exercise have been found to place stress on the bones, which in turn promotes a higher bone density over time.

Dietary Reference Intakes

The dietary reference intake (DRI) for calcium is 200–1,300 milligrams (mg) per day for children ages 0–13 and 1,000 mg per day for adult males and females. The recommendation for females over the age of 50 is 1,200 mg per day.

Deficiency Symptoms

Inadequate calcium intake results in muscle cramping and reduced energy levels. Rickets and stunted growth are also potential disorders related to a calcium-deficient nutrition plan. There are generally few calcium-rich nutritional sources of calcium, so most people will benefit from supplementation. In many cases, deficiency symptoms are not from a lack of calcium in the nutrition plan, but hypocalcemia is a result of the inadequacies of the calcium-regulating hormone calcitonin and parathyroid hormone as well as vitamin D.

ENZYME COFACTOR:

A nonprotein compound required for a protein's biological activity.

Toxicity Levels and Symptoms

The tolerable upper-intake level (UL) for calcium is 2,500 mg per day for all ages. Excess calcium intake over the short term may cause constipation or lead to the development of kidney stones in some people. Higher intake can also interfere with the absorption of iron, zinc, magnesium, and other essential minerals. Studies have shown that excess calcium intake over the long term can potentially lead to bone fractures, chronic gastrointestinal distress, and cardiovascular disease.

Food Sources

Nutritional sources of calcium include milk, cheese, ice cream, sour cream, cottage cheese, yogurt, broccoli, kale, collards, oysters, shrimp, salmon, clams, and calcium-fortified foods. Some supplemental sources of calcium include calcium citrate, calcium malate, calcium glycinate, and certain antacids.



Athlete Considerations

Studies support the adequate daily intake of calcium for maintenance of overall health, bone strength and growth during adolescence, and athletic performance. For athletes, the major considerations with calcium are specifically with female athletes, intake during childhood, and the prevention of bone stress and fractures when stress is applied during sports. Studies have determined that most youth females do not intake the daily recommendations of calcium and are, therefore, at risk for deficiency symptoms as adults. Daily doses up to 1,500 mg per day have been recommended for female athletes.

PHOSPHOROUS

Role in the Body

Phosphorus occurs in bone at approximately a one-to-two ratio with calcium, and it is involved in many of the same processes. It is recognized as the second-most abundant mineral in the body and makes up about 1 percent of total body weight. Phosphorus is present in bone, cellular fluids as phosphate ion, lipids, proteins, nucleic acids, **adenosine triphosphate (ATP)**, and creatine phosphate. Phosphorus is involved in cell permeability, metabolism of fats and carbohydrates, formation of ATP and energy storage, enzyme activity, and phospholipid transport of fatty acids. The chemical energy of the body is stored in high-energy phosphate compounds, like ATP and creatine phosphate. Phosphorus also has a role in collagen synthesis.

ADENOSINE TRIPHOSPHATE (ATP):

A complex organic chemical providing molecular energy to drive cellular processes.

DRIs

The DRI for children under the age of 18 and pregnant females is 1,200 mg per day; for adults over the age of 19, the recommendation is 700 mg per day. The increased intake is recommended for youth and pregnant females due to the rapid cellular growth they undergo in these life stages.

Deficiency Symptoms

Because phosphorus is abundant in most plants and animals, deficiency is rarely seen in adults, although it has been observed in cases of malnutrition and in clinical settings. Deficiency symptoms over time include poor bone formation, stunted growth, nervous system dysfunction, weakness, anorexia, tremors, and malaise. Acute lack of phosphorous has been found to accelerate **rhabdomyolysis**.

RHABDOMYOLYSIS:

The breakdown of muscle tissue releasing damaging amounts of protein into the blood.

Toxicity Levels and Symptoms

The UL for phosphorous is 4,000 mg per day for healthy adults. Chronic excessive intake of phosphorus has been reported to adversely affect calcium's function and metabolism and to stimulate bone loss. Toxicity symptoms include hypotension, **tachycardia**, and tetany.

TACHYCARDIA:

A condition causing the heart to beat at 100 beats per minute or faster.

Food Sources

Most Americans normally eat a range of foods that supply adequate amounts of phosphorus—about 1,500 mg per day—with grains providing approximately 30 percent of the daily intake. The most bioavailable sources are additives in processed foods, while plant sources have been determined to be the least bioavailable to humans during digestion, most likely due to the indigestible cellulose and cell walls. Good sources also include milk, fish, eggs, and asparagus.



Athlete Considerations

Athletes restricting their caloric intake, whether short term or long term, may struggle to get adequate phosphorous. In these cases, supplementation and the addition of nutrient-rich dairy products and foods rich in heme iron will support the cellular energy demands of higher activity levels.

MAGNESIUM

Role in the Body

Most of the magnesium in the body occurs in the bones, muscles, and soft tissues. Magnesium is involved in more than 300 biochemical reactions in the body and is a major factor in bone growth and strength. It plays a role in muscle and nerve function, activates enzymes, assists calcium and potassium uptake, helps regulate blood glucose levels, and is involved in glycolysis. It is essential for ATP metabolism, DNA and RNA synthesis, and protein formation. In addition, magnesium plays a big role in the homeostasis of smooth muscle tissue, specifically the heart muscles.

DRIs

The DRI for magnesium is 240 mg per day for males and females under 13 years of age. Adult females require 320 mg per day (slightly more during puberty), and adult males require 420 mg per day.

Deficiency Symptoms

Deficiency of magnesium is rarely seen, but symptoms include muscle weakness, cramps, and spasms as well as irritability, nausea, cardiac arrhythmia, and depression. These symptoms can be caused by decreased or inefficient absorption of magnesium in the gastrointestinal tract or as a result of medication interference.

Toxicity Levels and Symptoms

Intake of magnesium over 350 mg per day may lead to side effects in some individuals, specifically those with kidney disorders. Large amounts have a laxative effect, and several laxative products contain magnesium compounds for this purpose. Individuals with abnormal renal function may experience symptoms including depression, nausea, vomiting, and hypotension. Long-term deficiency can result in **metabolic syndrome**, skeletal deformities, and cardiovascular disease.

Food Sources

Nutritional sources of magnesium include green vegetables, whole grains, nuts, legumes, oats, and fruit. Fortified foods and cereals are also a good source of the mineral.

METABOLIC SYNDROME:

A set of disorders such as high blood pressure, high blood sugar, high cholesterol, and excess bodyfat that together can increase an individual's risk of heart attack and stroke.



Athlete Considerations

Of interest to athletes are several studies showing how supplementing with moderate amounts of magnesium (200–400 mg) improves strength and overall endurance. Studies have shown that individuals with higher levels of activity benefit from increased magnesium intake. The benefits are reducing lactic acid accumulation in the muscle tissue (delayed fatigue) as well as better performance when tested for leg extension strength, grip strength, and quadriceps torque production.

SULFUR

Role in the Body

Sulfur is derived from the essential amino acids cysteine and methionine (MET) and is a major enzyme cofactor. MET is not stored in the body, so a daily intake is vital for proper nutrition. Sulfur is a major component of oxidative reactions on a cellular level and helps the body fight free radicals and **reactive oxygen species**.

DRIs

There are no established DRIs for sulfur alone, but the DRI for the amino acids it is derived from ranges from 22 mg/kg for youth ages 2–12 years and 13 mg/kg daily for adults. According to the World Health Organization, infants younger than four months need 58 mg/kg of MET and cysteine daily.

Deficiency Symptoms

Deficiency is often observed with a lack of essential amino acid intake in individuals who are malnourished (whether through a lack of available food or voluntary low-calorie intake) or who eat a plant-based diet. Symptoms include brittle hair and nails, dental cavities, and decreased fertility. Chronic deficiency has been found to greatly increase the risk of cardiovascular disorders, stroke, and heart attack, especially in plant-eating populations. **Muscle wasting** is also a commonly observed side effect of amino acid deficiency.

Toxicity Levels and Symptoms

There is no specific upper limit for MET or cysteine, but research has shown that the amount of these amino acids ingested by the average American is sufficient. Supplementation is both uncommon and unnecessary. Chronic excess of these amino acids and sulfur can lead to brain damage, heart disease, or even death. Sulfur can also change the acidity of the blood and should generally be avoided by people with **acidosis**.

REACTIVE OXYGEN SPECIES:

The by-products of cellular metabolism as a result of stress or immune response.

MUSCLE WASTING:

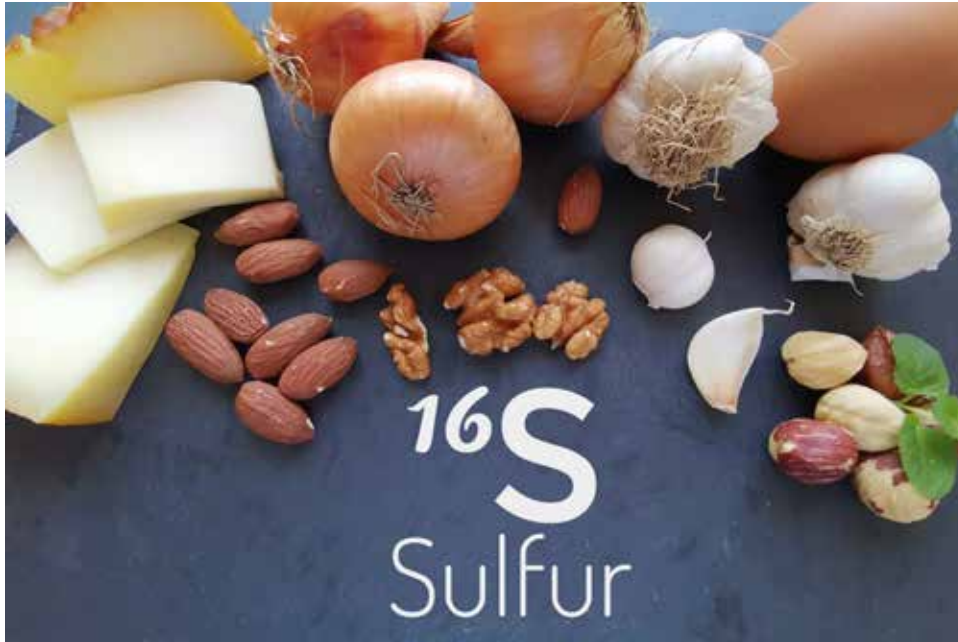
The rapid loss of muscle tissue mass and strength resulting from excess protein breakdown and, in many cases, reduced protein synthesis.

ACIDOSIS:

A condition in which blood pH is under 7.35, which can disrupt enzyme function and reduce insulin sensitivity.

Food Sources

Nutritional sources of amino acids include meat and meat products, grain, milk, and dairy products. Plant sources are not sufficient sources of cysteine or MET. Sulfur can also be found in onion, garlic, eggs, tree nuts, and cheese.



Athlete Considerations

Bouts of longer activity in endurance sports and athletics speed up the oxidative loss of amino acids in the body. Research has found that athletes participating in endurance and strength sports will require a higher protein and amino acid intake to support their cellular metabolic rate and prevent muscle wasting. Athletes consuming a vegan or largely vegetarian diet may need to supplement beta alanine, creatine, and other essential amino acids, but with proper supplementation, they can achieve similar performance as their meat-eating counterparts.

MINOR MINERALS

IRON

Role in the Body

Iron is well known as a component of hemoglobin, which carries oxygen throughout the body and takes the form of **myoglobin** for oxygen storage. Myoglobin is stored in the bone marrow, spleen, and liver. Hemoglobin releases oxygen throughout the body used for oxidative metabolism, while myoglobin stores and releases oxygen from the storage locations when the body is in need. The actual mineral iron is mostly stored in liver **hepatocytes** and released when needed.

MYOGLOBIN:

A red protein carrying and storing oxygen in muscle tissue.

HEPATOCTYES:

Liver cells making up 55–65 percent of liver mass; used for storage, bile production, metabolism, and digestion.

DRIs

The DRI for adult males and females is 8 mg per day. Females between the ages of 18 and 50 are recommended to intake 18 mg per day to compensate for the natural loss of iron with menstruation at childbearing age.

Deficiency Symptoms

Iron-deficiency anemia is a common and curable symptom of iron deficiency. It is a result of an imbalance of iron intake, iron storage, and natural iron loss preventing the full functioning of **erythrocytes** in the circulatory system. The symptoms of iron-deficiency anemia include fatigue, restless leg syndrome, and impaired cognitive function. Additionally, iron deficiency has been linked to lower immune system function, making individuals more susceptible to chronic and acute disease.

Toxicity Levels and Symptoms

The UL for iron is 45 mg per day for adults. Excessive intake of iron is becoming more common with increased use and overuse of multivitamins. High levels of iron intake have been attributed to causing or increasing risk for metal toxicity, leading to oxidative stress, intensifying aging muscle atrophy, **rosacea**, and **pulmonary alveolar proteinosis**. These conditions can be mitigated when ferrous sulfate is supplemented instead of the mineral iron. Ferrous sulfate is a form of iron readily absorbed in the body but not stored in the liver the same way as iron is.

Food Sources

Foods high in iron include red meats, poultry, fish, iron-fortified foods, liver, molasses, nuts, clams, chocolate, legumes, and bread. Supplementation of iron and ferrous sulfate has become a primary source of iron for most people needing to increase their iron intake.

ERYTHROCYTES:

ROSACEA:

PULMONARY ALVEOLAR PROTEINOSIS:



Athlete Considerations

The oxygen-carrying properties of iron make it a critical mineral for athletes. High or excessive doses have not been found to be beneficial to endurance or strength athletes. Similar to what is found in the general population, males tend to intake sufficient iron, while females are more likely to exhibit deficiency symptoms or anemia.

Some high-level athletes have attempted to dope during training and competition to enhance performance. This is the practice of using blood transfusions to increase serum hemoglobin levels and thus their oxygen-carrying capacity to increase overall performance. While blood doping is not necessarily common, it has gained notable attention in the past two decades in the Olympics and professional road cycling, where it is against the rules or not allowed to maintain ethical standards in sport.

ZINC

Role in the Body

Zinc has many important metabolic roles in the body and is part of various **metalloenzymes** that play roles in human growth and development, testosterone production, DNA synthesis, cell replication, fertility and reproduction, and prostate gland function. Zinc functions as a free ion in cells, as part of the synthesis of biomolecules, and as part of enzymes. Basically, zinc is an important factor in all the major functional systems in the human body.

METALLOENZYMES:

Enzyme proteins containing metal ions.

DRIs

The DRI for zinc is 11 mg per day for adult males and 8 mg per day for adult females. Pregnant and lactating females are suggested to intake 11 mg per day, and children under the age of 13 require only 3–5 mg of zinc per day.

Deficiency Symptoms

Zinc deficiency is relatively common in developing countries, and it is typically caused by malabsorption versus lack of intake. A deficiency in zinc can cause growth retardation, loss of appetite, skin changes, disrupted immune system, delayed sexual maturation, night blindness, and impaired healing. It was previously believed that diets high in protein or fiber impaired zinc absorption, but current research does not support this idea.

Toxicity Levels and Symptoms

The UL of zinc is 40 mg per day for adults. Excessive zinc intake can result in adverse effects, such as reduction of high-density lipoproteins, inhibited copper absorption, nausea, gastric distress, headaches, dizziness, lethargy, and fatigue.

Food Sources

Nutritional sources of zinc include meat, whole-grain products, liver, eggs, seafood, herring, oysters, oatmeal, maple syrup, and dry yeast. It is relatively easy to come by; however, vegetarians and vegans should focus on nuts and seeds, tempeh, tofu, legumes, and fortified cereals and dairy products for optimal zinc intake.



Athlete Considerations

Studies support zinc as an essential mineral for strength and endurance athletes to support immune function and the body's ability to withstand and recover from high-intensity exercise. However, no evidence exists for excessive doses above the DRI for zinc.

IODINE

Role in the Body

Iodine is required in all stages of life, including fetal development, puberty, and aging. It is metabolized for use in the body through the hypothalamus, pituitary gland, thyroid gland, and circulatory system. Iodine is required for proper thyroid function and occurs in two thyroid gland hormones: thyroxine and triiodothyronine.

DRIs

Children up to age eight require 90 micrograms (mcg) of iodine per day, while adult males and females require 150 mcg per day. Pregnant females are recommended to take in 220 mcg per day, while lactating females require approximately 250 mcg of iodine per day to support a healthy metabolism with the demands of breastfeeding.

Deficiency Symptoms

Since iodine is essential for thyroid gland function, a deficiency of iodine is associated with thyroid gland disorders (endocrinopathy) and is the most preventable cause of mental retardation. Goiter is a condition that causes enlargement of the thyroid gland and is caused by inadequate iodine intake and uptake as well as the presence of thyroid-interrupting substances known as **goitrogens**. As with many other minerals covered in this chapter, deficiency symptoms are often a result of malabsorption versus lack of consumption.

GOITROGENS:

Toxicity Levels and Symptoms

The UL for iodine in adults is 1,100 mcg per day. Excess intake of iodine is generally well tolerated, and toxicity is rare in humans. However, excess iodine intake can promote various side effects, including rash, headache, and metallic taste in the mouth, and may result in reduced binding in the thyroid gland, causing hypothyroidism or goiter.

Food Sources

Nutritional sources include iodized salt, seafood, cod, cod liver oil, halibut, oysters, kelp, spinach, meat, cheese, milk, and coffee. Iodized salt has been a major source of iodine in the past, but the increased use of sea salts that are not fortified with iodine make seafood and other fortified sources more important.



Athlete Considerations

Iodine loss through sweat and in urine is the major concern for strength and high-intensity athletes. Studies have explored athletes' higher rates of fluid, electrolyte, and mineral loss during exercise and how they can contribute to an iron deficiency or related symptoms. Megadoses of iodine are not necessary; however, athletes can benefit from additional electrolytes and the use of fortified salt to maintain iodine levels.

SELENIUM

Role in the Body

Selenium is a vital component of an antioxidant enzyme called glutathione peroxidase. Glutathione peroxidase protects the body from free radical damage, in particular **hydroperoxides**. In this role as an antioxidant, selenium helps prevent damage to the body's tissues, cells, and molecules, which can lead to reduced risk of degenerative diseases such as coronary heart disease, arthritis, and certain cancers. It also plays a role in thyroid hormone production, DNA synthesis, and reproduction.

HYDROPEROXIDES:

Oxygenated products of polyunsaturated fatty acids.

DRIs

The DRI for selenium is 55 mcg per day for adults. Pregnant females are recommended to intake 60 mcg per day, while lactating females are recommended to intake 70 mcg per day.

Deficiency Symptoms

Low selenium intakes have widespread adverse effects on the body due to lowering the body's defense against hydroperoxide free radicals. Deficiency symptoms include hair loss, growth retardation, pancreatic problems, depression and anxiety, muscular discomfort, and myodegenerative diseases such as muscle weakness.

Toxicity Levels and Symptoms

Selenium has a UL of 400 mcg per day. Chronic excessive intake of selenium results in brittle fingernails, hair loss, fatigue, abdominal pain, nausea, increased dental caries, diarrhea, and irritability. Accidental overdoses and acute toxicity symptoms have been observed resulting from oversupplementation with liquid nutritional supplements in the past.

Food Sources

Nutritional sources of selenium include Brazil nuts, meat, seafood, kidney, liver, and some whole-grain products. Selenium content in food is dependent upon the selenium content of the soil where crops are grown and the food eaten by animals and is, therefore, variable by geographical region.



Athlete Considerations

Studies support the adequate daily intake of selenium for maintenance of overall health and performance. The antioxidant properties have been found to be the most beneficial aspect of adequate selenium intake for athletes, as their metabolic processes are accelerated during vigorous exercise.

COPPER

Role in the Body

Copper is present in many enzymes, and it is involved in energy production, melanin pigment synthesis, myelin formation, immune function, glucose metabolism, and cholesterol metabolism. It has an important role in connective tissues of arteries, bones, and the heart as well as nerve signal propagation in the brain and spinal cord. Nearly half of the copper in the human body is stored in the skeleton and muscle tissue, with a large proportion found in the kidneys and heart as well.

DRIs

The DRI for copper in adults is 900 mcg per day, with young children under 13 years of age requiring about half as much. Pregnant females are recommended to intake 1,000 mcg per day, and lactating females are recommended to intake 1,300 mcg per day.

Deficiency Symptoms

Inadequate copper intake can cause anemia, bone abnormalities, defects in skin pigmentation, reproductive failure, reduced iron uptake and absorption, decreased arterial elasticity, and defective formation of connective tissues. Copper and iron are closely linked, as the uptake of iron for hemoglobin is copper dependent. Current research is exploring a possible link between copper deficiencies and bone mineral density and osteoporosis in postmenopausal women.

Toxicity Levels and Symptoms

The UL for copper is 10 mg per day for adults. Copper toxicity is rare, as the mineral is usually found bound only to proteins in the body and not free floating or in serum plasma. Excessive copper intake can cause nausea, vomiting, hepatic necrosis, and abdominal pain and is mostly observed in infants with poor intestinal absorption. For the small population with Wilson's disease, excessive copper intake can be fatal. Wilson's disease is characterized by the accumulation of copper in the body, leading to toxic effects on the liver, kidney, eyes, and nervous system.

Food Sources

Rich sources of copper include organ meats (especially liver), nuts and seeds, seafood, cocoa, chocolate, meat, legumes, and mushrooms.



Athlete Considerations

Research on male and female athletes of college age and older has shown that intake of copper is adequate. The recommended DRIs are adequate for the general population and athletes, and there has been no research to support that higher doses benefit athletes of any intensity.

MANGANESE

Role in the Body

Manganese is required for cellular energy production; is part of enzymes; aids in bone and connective tissue formation and collagen synthesis; and facilitates carbohydrate, amino acid, and cholesterol metabolism. A small percentage of nutritional manganese is absorbed as it is excreted constantly in bile.

DRIs

The DRI and adequate intake of manganese for adult males is 2.3 mg per day, and adult females require 1.8 mg per day. Pregnant and lactating females are recommended to intake 2 mg per day and 2.6 mg per day, respectively.

Deficiency Symptoms

Although manganese deficiency is rarely observed, symptoms include growth retardation, poor bone and connective tissue formation and maintenance, impaired glucose tolerance, poor reproductive function, and disturbance of energy metabolism. Deficiency has also been linked to the development and advancement of osteoporosis and arthritis. The intake of other minerals such as calcium (from dairy), iron, and phosphorous can adversely affect manganese uptake and absorption.

Toxicity Levels and Symptoms

The UL of manganese is 11 mg per day for adults. Excessive manganese intake has relatively minimal effect on human health. Not many cases of nutritional manganese overdosing are currently reported; however, those who work with or inhale manganese dust exhibit nervous system pathology, nerve lesions, and symptoms similar to Parkinson's disease.

Food Sources

Nutritional sources of manganese include brussels sprouts, spinach, peas, turnip greens, wheat germ, meat, buckwheat, barley seed, beets, bananas, corn, lettuce, oatmeal, and other whole-grain and cereal products. Studies have shown that about 37 percent of nutritional manganese comes from grains and about 18 percent comes from vegetables in the average American diet.



Athlete Considerations

Regarding athletes of all ages, the involvement of manganese in energy metabolism is its most notable property. The DRI recommendations have been found to be efficient for athletes of all types, and due to the constant loss of manganese in bile during digestion, daily intake is strongly recommended.

CHROMIUM

Role in the Body

Chromium's major role is in the functioning of insulin; it is needed as a cofactor. Chromium also plays a role in the metabolism of nucleic acids (DNA and RNA) and helps to maintain their structure and gene expression. It works in fatty acid and cholesterol formation in the liver, and some studies have shown a lowering of cholesterol with chromium supplementation. Chromium has received attention in the media as an anabolic steroid alternative, as it has been reported to decrease bodyfat percentage and increase lean body mass in humans.

The most important and relevant current chromium research is regarding its activity as a cofactor in insulin dependence and patients with type II diabetes. Studies have shown that

deficiency of chromium has a negative effect on insulin response as the disease progresses. Conversely, patients treated with chromium in the form of chromium picolinate in 30 mcg daily doses had a measurable reduction in the degree of insulin resistance. This simply means that increasing nutritional chromium levels can improve the functioning of insulin, which could result in a higher rate of cellular uptake of glucose and amino acids into the cells. The cells then use these nutrients for energy and growth. If insulin is not working properly, glucose and amino acids are likely to circulate back to the liver and be converted to fat and stored. These studies show implications for both overweight patients and those with diabetes, and these conditions are often linked.

DRI

The DRI for chromium is 20–25 mcg per day for adult females and 30–35 mcg per day for adult males (with lower ranges suggested for adults over 50 years of age). The intake for pregnant and lactating females is 30 and 45 mcg per day, respectively.

Deficiency Symptoms

Outside of malnutrition, deficiency in chromium has been determined to be uncommon. Research has shown that chromium uptake can be greatly reduced when someone has a nutrition plan high in simple sugars. This type of high-sugar nutrition plan paired with low or inadequate intake of chromium has been found to lead to adult-onset (type II) diabetes, cardiovascular disease, and neuropathy.

Toxicity Levels and Symptoms

A UL has not been established for chromium at this time. Chronic excessive chromium intake has been attributed to renal failure and, when inhaled, dermatitis and other skin reactions, asthma, and gastric upset.

Food Sources

Nutritional sources of chromium include meats, mushrooms, liver, whole-grain bread, brewer's yeast, black pepper, vegetables, and nuts.



Athlete Considerations

While larger-than-the-DRI doses of chromium are not recommended for athletes, supplementation is preferred. Studies have shown that the efficiency of protein, carbohydrate, and fat metabolism is dependent on chromium stores, so the restoration and maintenance of chromium levels in athletes are advantageous. The potential anabolic effect of chromium is generally minimal and needs further research.

DID YOU KNOW:

Did you know chromium and chromium picolinate are some of the best-selling fat loss supplements in the United States? While some studies have established a link between fat loss, muscle gain, and chromium, the doses required to achieve visible results are too high for human consumption and may lead to toxicity symptoms.

When clients ask about weight loss supplements, a coach should remind them there are no shortcuts to lasting fat loss and healthy weight. Clients should have a balanced nutrition plan, proper calorie intake, and the proper vitamins and minerals for optimal health!

MOLYBDENUM

Role in the Body

Molybdenum is a trace mineral. Its presence in the body is extremely small, but it is nevertheless recognized as an essential nutrient and required by the body for maintenance of good health. This mineral is present in enzymes such as xanthine oxidase, sulfite oxidase, and aldehyde oxidase. These compounds are involved in energy production, nitrogen metabolism, and uric acid formation.

DRIs

The DRI for adult males and females is 45 mcg per day, while pregnant and lactating females are recommended to intake 50 mcg per day.

Deficiency Symptoms

No molybdenum-deficiency symptoms in humans have been reported, as it is rare. Because it is required in such small quantities, adequate amounts of molybdenum can be found in most nutrition plans. Some studies suggest that soy, though it contains relatively large amounts of the mineral, has low bioavailability in humans.

Toxicity Levels and Symptoms

The UL for molybdenum is 2,000 mcg per day (2 mg per day) in adults over the age of 19. Ingestion of large amounts of molybdenum may cause gout (15 mg daily for several months), retarded growth, and a reduction of copper uptake and absorption. Conversely, those with a deficiency in nutritional copper or dysfunction in copper intake may be at an increased risk of molybdenum toxicity.

Food Sources

The soil content in different regions of the world has a great effect on molybdenum in nutrition. Healthy sources include grains, nuts, and soy (though bioavailability is low, as mentioned previously). Animal products, vegetables, and fruits are generally low in this mineral.



Athlete Considerations

Any intake above the DRIs for athletes has not been shown to produce higher levels of athletic performance. Athletes can get the same energy production and toxin-filtering benefits as the general population for this mineral.

FLUORIDE

Role in the Body

Fluoride has a major role in oral health, namely enamel strength and prevention of dental cavities (caries). It is also found in bone and in soft body tissues in small amounts as calcium fluoride. Fluoride's role in increasing resistance to tooth decay is most notably seen in children, and this is a major reason why youth dental maintenance is so important. Fluoride intake has also been associated with increased skeletal bone integrity. There is some evidence that maintaining efficient fluoride intake may help reduce osteoporosis later in life. The primary source of fluoride for those in developed countries is the water supply.

DRIs

The DRI for fluoride is 4 mg per day for adult males and 3 mg per day for adult females. Pregnant and lactating females are recommended to intake the same as adult females, and it has been determined that they transfer adequate amounts of fluoride to their fetus and breastfeeding infant.

Deficiency Symptoms

Deficiency in fluoride has been linked to increased tooth decay and possibly linked to osteoporosis. No other physical symptoms have been observed.

Toxicity Levels and Symptoms

The UL of fluoride is 7 mg per day and is estimated to be out of reach for the average American. Intake of this mineral above the DRI, however, is not uncommon due to the large number of oral products ranging from toothpaste to sensitivity medications containing the mineral. Excess fluoride intake causes mottling of teeth and affects bone health, kidney function, and possibly muscle and nerve function. Fluoride is one of the most reactive elements, and, as such, excess amounts can disrupt cellular metabolism and result in a buildup of hydrogen peroxide. Acute intake of high amounts of fluoride (5–10 grams sodium fluoride) can cause severe gastric upset, nausea and vomiting, and weakness, which has been reported to cause death. This amount is far above the normal and average range of fluoride ingestion, 1–4 mg per day. Chronic toxicity symptoms include renal failure and symptoms of malnutrition.

Food Sources

Fluoride occurs in many foods in low amounts. Fluoridated water, beverages, and tea are the most common nutritional sources of fluoride for most people.



Athlete Considerations

The DRIs apply to athletes of all types. There is no evidence that exercise of any intensity or duration affects fluoride uptake or use in the human body.

BORON

Role in the Body

Boron is a trace mineral occurring in the body in small amounts. It has been established as an essential mineral in humans due to its role in bone growth, tissue healing, inflammation, and the body's use of estrogen, testosterone, and several other vitamins. Some research even suggests boron is vital in evolution on earth.

DRIs

The DRI of boron has not been established, although the median intake for adult males and females has been determined to be 0.75–0.96 mg per day on average. Pregnant and lactating females should average just over 1.0 mg per day.

Deficiency Symptoms

Boron concentration in the soil varies by geographical location. Deficiency has not been observed, as the DRI is unknown for this trace mineral.

Toxicity Levels and Symptoms

No UL for boron exists, though it is not recommended to exceed 20 mg per day for adults over the age of 18.

Food Sources

Nutritional sources of boron include avocado, raisins and grapes, lentils, nuts and nut butters, and kidney beans.



Athlete Considerations

No direct benefits have been found for athletes who intake higher-than-average levels of boron. However, athlete studies are in progress to examine the effect of boron supplementation on endogenous steroid hormones and how this mineral can be a safe performance-enhancing substance for athletes of all levels.

ELECTROLYTES

Electrolytes: substances creating either a cation (positive) or an anion (negative) in the body and regulating fluid balance, blood pressure, blood pH, and muscle contraction.

ROLE IN THE BODY

The main function of these electrolytes is maintenance of the balance of fluids in the body between cells and the bloodstream. Other functions of these electrolyte minerals are summarized below.

Table 8.1 Main Functions of Each Electrolyte.

ELECTROLYTE	MAIN FUNCTIONS
Sodium	<ul style="list-style-type: none">• Extracellular cation• Regulation of osmolality• Regulation of body fluid balance• Active transport across cell membranes• Uptake of some nutrients in intestines• Muscle contraction and nerve impulse transmission
Chloride	<ul style="list-style-type: none">• Extracellular anion• Maintains proper blood volume and pH• Control of fluid balance
Potassium	<ul style="list-style-type: none">• Intracellular cation• Fluid balance• Nerve transmission and muscle contraction• Glycogen formation

DID YOU KNOW:



Did you know electrolyte drinks may not be the best source of electrolytes? Products such as Gatorade, Propel, Drinkfinity, Naked Juice, and even Mountain Dew are sold as electrolyte drinks for the general population. It is important for coaches to teach clients how to read nutrition labels and identify the other ingredients in such drinks, including sugars, artificial sugars, and additives.

A coach should take the time to discuss electrolytes, proper water intake, and, for clients who participate in sports, when and how to maintain their electrolytes for optimal performance. A coach can set clients up for success and minimize additional calories or potentially harmful additives in their nutrition plan!

DRIS

There are no established DRIs for the three major electrolytes, but a safe minimum intake has been determined. The safe minimum for sodium is 500 mg per day, according to nutritional guidelines, with 2,000–3,000 mg being the high end of the range.

Chloride is often combined with sodium, and a safe minimum of daily intake is about 42 mg per day.

Average intake of potassium has been found to naturally fall between 1,000 and 2,500 mg per day, depending on geographic region and ethnic group. Ethnic groups consuming more fruits and vegetables than others typically have a higher intake. In the United States, the established minimum intake of potassium is 1,600–2,000 mg per day.

DEFICIENCY SYMPTOMS

Deficiency of electrolytes is not normally observed, except under conditions of severe dehydration, during prolonged periods of exercise without proper hydration or electrolyte replenishment, and in individuals with renal disease. Side effects include dizziness, fainting, heavy sweating, confusion, and reduced physical coordination.

TOXICITY LEVELS AND SYMPTOMS

Excessive intake of sodium and chloride (because they occur together in food) can lead to hypertension, fluid balance problems, and edema. High potassium intake—that is, 18 grams or more—will lead to acute hyperkalemia, which can cause cardiac arrest and prove fatal.

FOOD SOURCES

These three electrolytes occur in all foods and are especially prevalent in water (tap and bottled) and processed foods as an additive. Sodium and chloride are supplied by food mostly as table salt. Potassium is present in all foods but is particularly high in fruits and vegetables.

ATHLETE CONSIDERATIONS

Many sports drinks contain water, carbohydrates, and electrolytes. Use of these drinks is recommended for athletes during and after exercise. Long-distance and ultralong-distance athletes need to make sure they are first maintaining adequate water and carbohydrate intake and then focus on appropriate levels of electrolytes. Drinks lower in electrolytes are best during exercise because higher electrolyte concentrations will delay gastric emptying and impair hydration and carbohydrate use during physical activity.

Table 8.2 Daily Mineral Intake Reference Summary.

US Minimum and Upper Mineral Reference Intakes (total intake from food and supplements)			
	DRI for men	DRI for women	Tolerable upper intake
Calcium	1,000 mg	1,000 mg	2,500 mg
Chromium	35 mcg	25 mcg	Not established
Copper	0.9 mg	0.9 mg	10 mg
Iodine	150 mcg	150 mcg	1,100 mcg
Iron	8 mg	8 mg	45 mg
Magnesium	240 mg	240 mg	350 mg
Manganese	2.3 mg	1.8 mg	11 mg
Molybdenum	45 mcg	45 mcg	2,000 mcg
Phosphorus	700 mg	700 mg	4,000 mg
Selenium	55 mcg	55 mcg	400 mcg
Zinc	11 mg	8 mg	40 mg
Potassium	4,700 mg	4,700 mg	Not established
Sodium	1,500 mg	1,500 mg	2,300 mg
Chloride	2,300 mg	2,300 mg	3,600 mg
Boron	Not established	Not established	20 mg
Fluoride	4 mg	3 mg	7 mg

Note: This information is for educational purposes only. The example guidelines are for model healthy adult athletes, for short-term use during periods of athletic training. Typically, the exact nutritional requirements for each person differ and, for best results, should be determined working with a health care professional.



CHAPTER 9

WATER AND HYDRATION

LEARNING OBJECTIVES

- 1 | Understand the structure and function of water for life and within the human body.
- 2 | Explain the role of water in physiological processes.
- 3 | Describe how water is absorbed and excreted in the body.
- 4 | Understand the importance of water for athletic performance.

Water as an aspect of nutrition is often neglected. Macronutrients are defined as nutrients providing calories or energy and are required in large amounts to maintain bodily functions and carry out the activities of daily life. Nutrition guidelines identify three macronutrients: fat, carbohydrate, and protein. Arguably, water could be included as a macronutrient. The adult human body is 50–60 percent water and can survive only approximately three to four days without ingesting water in some form.

WATER

POLAR:

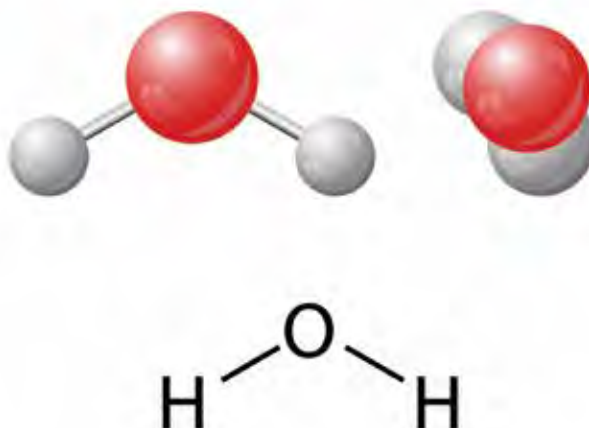
Describes a molecule with a positive and negative charge on opposite sides.

SPECIFIC HEAT:

The heat required to raise the temperature of a substance by one degree.

Water is a liquid at room temperature with the chemical formula H_2O , meaning two hydrogen atoms are bound to one oxygen atom. This chemical structure makes water molecules **polar**, where one side of the molecule has a slight positive charge—hydrogen—while the other has a slight negative charge—oxygen. Due to its polarity, water can interact with many other molecules by weakening the forces that bond them. Additionally, water has a relatively high **specific heat**, meaning it easily absorbs and transports heat.

Figure 9.1 Chemical Composition of Water.



HOMEOSTASIS:

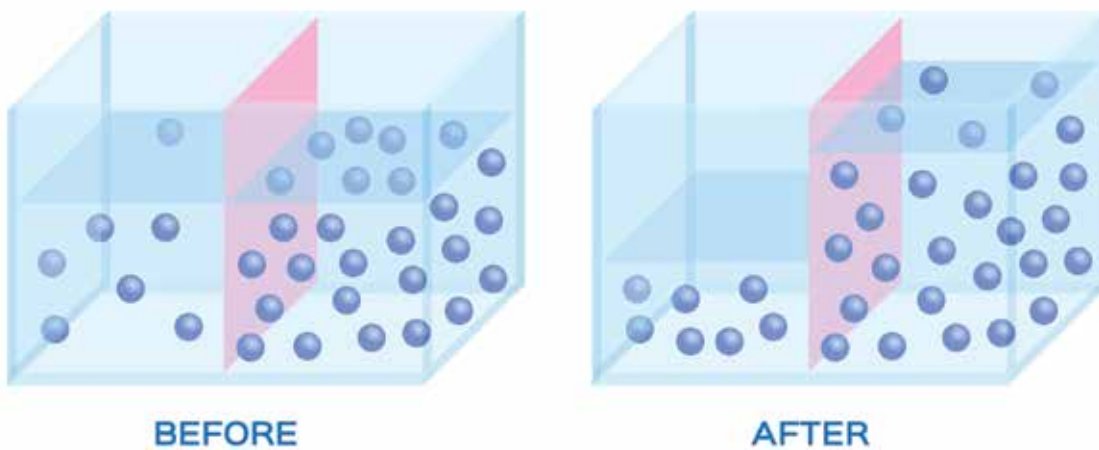
The body's ability to maintain a stable equilibrium between processes that are dependent on each other.

OSMOSIS:

A process by which molecules pass through a semipermeable membrane from an area of high concentration to an area of low concentration.

Water is a key factor in maintaining **homeostasis**, which is the body's ability to maintain a stable equilibrium between processes that are dependent on each other. In terms of hydration, homeostasis is achieved through a constant transfer of fluids between the compartments of the human body. This transfer of fluids is driven mainly by **osmosis**, which is when molecules pass through a semipermeable membrane from an area of high concentration to an area of low concentration.

Figure 9.2 Osmosis.



In the before image, the compartment on the left has a higher concentration of water and a lower concentration of molecules. The semipermeable membrane (red) allows the water to move from one compartment to the other but not the molecules. In the after image, water has moved into the compartment on the right to balance the water concentration as it relates to the concentration of molecules.

The overall volume of water found in the human body is known as **total body water**. Total body water is divided among many areas within the body. **Intracellular water** is located within the cells of the body and comprises approximately 68 percent of total body water. **Extracellular water** is located outside the cells and can be further split into **interstitial fluid** and **plasma volume**. Interstitial fluid is located in the space between cells and makes up about 24 percent of total body water. Plasma volume relates to the blood plasma in the veins and arteries, which makes up about 7 percent of total body water. Due to the relative concentration in each compartment, water is constantly transferred to maintain homeostasis.

The amount of total body water is controlled by built-in mechanisms. Urine production is the primary means by which the body gets rid of excess fluid, while the sensation of thirst initiates water intake. Complex systems involving several physiological systems of the body control these processes to achieve fluid balance and contribute to overall bodily homeostasis.

TOTAL BODY WATER:

The entire amount of water found in the human body.

INTRACELLULAR WATER:

Water within the cells of the body.

EXTRACELLULAR WATER:

Water outside the cells in the body.

INTERSTITIAL FLUID:

Water in the space between cells in the body.

PLASMA VOLUME:

The water in plasma in the veins and arteries..

HYPOHYDRATION:

A state of decreased total body water.

EUHYDRATION:

A state of adequate total body water as regulated by the brain.

HYPERHYDRATION:

A state of excessive total body water content.

UNDERHYDRATION:

A state in which hormones used to regulate fluid balance are activated; however, total body water is not significantly reduced, and thirst has not been stimulated..

DID YOU KNOW:

The term voluntary dehydration was first described by John Greenleaf and Frederick Sargent II in 1964? This phenomenon describes how humans tend to delay rehydrating themselves after losing total body water.

DID YOU KNOW?

Water has the highest surface tension of all liquids due to the hydrogen bonding present in water molecules? High surface tension is the tendency for liquids to shrink to the minimum surface area possible, and it gives water many of its unique properties.

Surface tension allows the formation of dew and for bugs to seemingly float on water.



HYDRATION STATUS

Total body water describes the amount of water in the human body at any point in time.

Hypohydration is a state of decreased total body water, while **euhydration** is a state of adequate total body water as regulated by the brain. **Hyperhydration** is a state of excessive total body water content. Dehydration specifically differs from these three states as it describes the process of losing body water. **Underhydration** is the state in which the hormones used to regulate fluid balance are activated; however, total body water is not significantly reduced, and thirst has not been stimulated. Underhydration is also referred to as mild hypohydration or pre-dehydration.

Determining Hydration Status

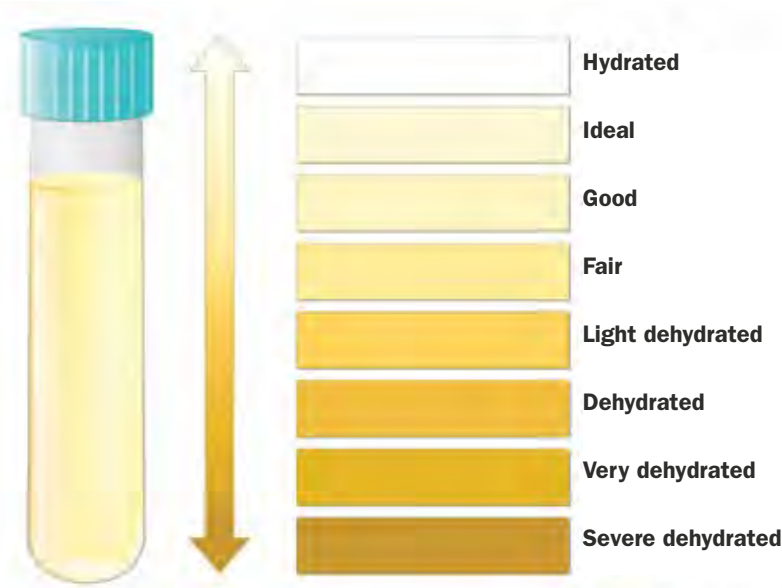
A nutrition coach must understand the current techniques used to measure hydration. There are several simple techniques as well as more detailed ways to measure hydration with the proper equipment.

Body mass changes are most common in high-level athletic settings. To accurately measure total body water loss using body mass, the weight of all substances going in (food, water, and other beverages) and out (urine and fecal matter) must be tracked. Once these variables are accounted for, changes in body mass can be attributed to sweat loss, therefore providing an index of total body water loss. (The small losses in body water occurring during exhalation

are generally disregarded.) To accurately assess hydration using this method, at least three consecutive days of body mass measurement are required. Although more expensive and invasive than measuring changes in body mass, blood samples as well as urine samples are also used to measure hydration status.

Measurement of plasma and **urine osmolality** requires expensive equipment generally used only in laboratory settings. Urine osmolality is a measure of urine concentration where large values indicate concentrated urine and small values indicate diluted urine. **Urine-specific gravity** and **urine color** are relatively inexpensive techniques. Urine-specific gravity is a measure of urine concentration comparing the density of urine to the density of water and is easily measured using an inexpensive handheld tool known as a **refractometer**. Urine color is the easiest way for people to self-assess their hydration status based on a scale of light to dark to indicate degrees of hydration.

Figure 9.3 Urine Color Chart.



Darker urine pigmentation indicates dehydration, while lighter or colorless urine pigmentation indicates hydration.

A single urine sample taken at one point during the day does not define an individual's hydration habits, considering urine measurements and volume can vary throughout the day. Therefore, a 24-hour urine collection is the most inclusive technique. However, this technique does present logistical challenges. If a single urine sample must be used, a collection from early to late afternoon most closely reflects a 24-hour measurement.

URINE OSMOLALITY:

A measure of urine concentration where large values indicate concentrated urine and small values indicate diluted urine.

URINE-SPECIFIC GRAVITY:

A measure of hydration using the density of urine compared to the density of water.

URINE COLOR:

The pigmentation of urine used as a measure of hydration.

REFRACTOMETER:

A tool to measure urine-specific gravity.

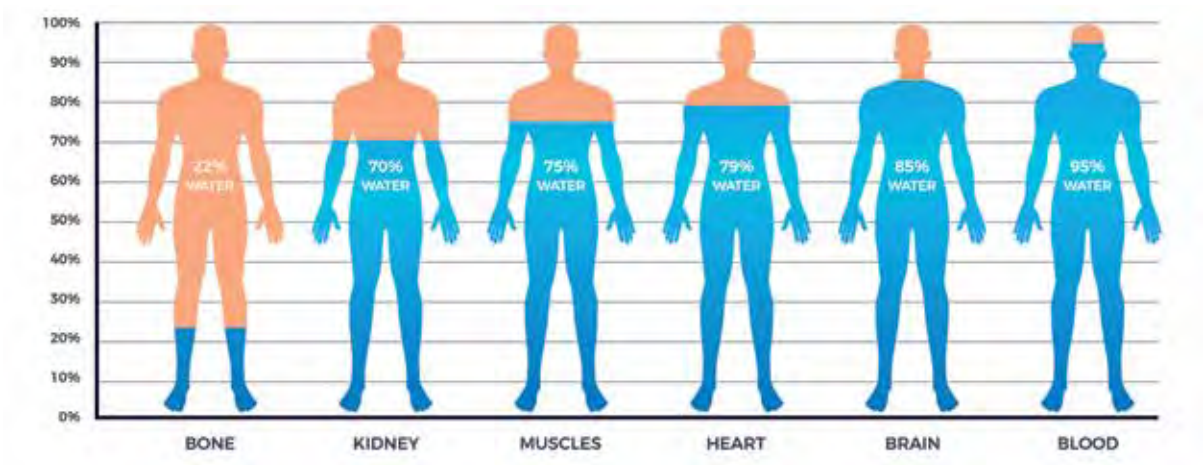
THE ROLE OF WATER IN THE BODY

Water is involved in many processes in the body, including the following:

- Cellular metabolism
- Temperature regulation
- Solute balance
- Transportation of nutrients
- Cellular waste clearance
- Maintaining homeostasis
- Digestion
- Balancing pH
- Waste elimination
- Oxygen delivery

These processes are crucial for human survival and establish water as one of the most important aspects of life. The major organ systems and structures of the human body are largely water and rely on adequate hydration for full function. While humans can last up to three to four weeks without food, humans can last only approximately three to four days without water.

Figure 9.4 Water Composition of the Human Body.



Recent research explores how inadequate hydration may contribute to chronic diseases that are currently afflicting populations across the globe. The most convincing science indicates inadequate water intake may affect how the human body controls blood sugar and the health of kidneys. Although other factors play a role, the hormonal response to inadequate water intake is largely responsible for many of these negative health aspects.

PHYSIOLOGY OF FLUID BALANCE

Two mechanisms are responsible for regulation of fluid balance: one influenced by blood volume and the other by blood plasma concentration. As blood volume decreases due to a loss of total body water, the hormone **aldosterone** is released, which helps the body retain sodium. It is well understood that sodium and water move on a gradient together. Thus, with increased sodium concentrations, water concentrations will also increase in the form of **water retention**.

Fluid balance is also regulated by the concentration of blood, known as **osmolality**, which is the concentration of plasma in the blood. To better understand **plasma osmolality**, it can be compared to a swimming pool filled with salt water. If more salt is added to the pool, the ratio of salt to water increases. Additionally, if fresh water is filtered out of the pool, the ratio of salt to water in the pool also increases. The pool in this scenario represents the fluid present in human blood. As the amount of sodium—the salt in the pool—increases in plasma from dietary sources, or fresh water is removed via urine and sweat, the concentration of plasma changes. The main electrolyte driving changes in plasma osmolality is sodium, but potassium and magnesium also have a small effect.

Plasma osmolality is closely monitored by the nervous system to maintain homeostasis. As plasma osmolality increases, the nervous system senses the change and triggers the release of the hormone **arginine vasopressin (AVP)**, also known as antidiuretic hormone, which helps conserve body water by limiting the amount of water lost through urine.

The pool of salt water will help to better visualize this process. A hose removes the salt water from the pool with a filter at the end, separating the salt from fresh water. If filtered fresh water is put back into the pool, the concentration of salt in the pool would change. In this scenario, the pool represents the plasma in the body, and the filter represents AVP. If fresh water—that is, plasma—is put back into the pool, the concentration of salt in the pool will decrease. The concentration of the water that was filtered and not put back into the pool will also change. Since fresh water has been removed, this will create an increase in concentration. This process represents urine production in the human body. Since the fresh water is reabsorbed back into the bloodstream and does not contribute to urine production, urine concentration in the kidneys and bladder increases, resulting in a small amount of highly concentrated urine. In a hydrated state, water remains in the tubules of the kidney, depending on the presence or absence of AVP, and becomes diluted urine to be voided.

ALDOSTERONE:

A hormone produced in the adrenal glands responsible for sodium conservation.

WATER RETENTION:

The accumulation of water in the cells and body cavities.

OSMOLALITY:

The concentration of plasma in the blood.

PLASMA OSMOLALITY:

A measure of the concentration of electrolytes and other solutes in plasma.

ARGININE VASOPRESSIN (AVP):

A hormone released when plasma osmolality increases; responsible for fluid reabsorption from the kidneys into the bloodstream.

RECEPTOR:

A group of specialized cells on or in a cell interacting with specific circulating hormones.

VASOPRESSIN 2 RECEPTORS:

Vasopressin receptors located in the kidney that are responsible for limiting the amount of fluid lost through urine production.

VASOPRESSIN 1A RECEPTORS:

Vasopressin receptors located in liver tissue that increase the amount of liver glucose production when activated.

CHRONIC KIDNEY DISEASE (CKD):

the gradual decreased kidney function over a long period of time.

GLUCOSE REGULATION

Non-modifiable risk factors, such as genetics, age, and sex, play a role in the development of type 2 diabetes along with overall lifestyle factors including obesity, poor nutritional habits, and inactive lifestyles. Recent studies suggest elevated levels of the hormone AVP, as seen with chronic low water intake, may be a potentially modifiable risk factor. AVP is responsible for water retention at the kidney level. When water intake is chronically low, glucose regulation may be impaired.

When humans are in a hypohydrated state, the brain signals a release of hormones into the bloodstream. A **receptor** is a group of specialized cells on or in a cell interacting with specific circulating hormones. When these hormones interact with their specific receptor, a cascade of events occur, leading to a desired outcome or cellular product.

AVP, like most hormones, has specific receptors located throughout the body. **Vasopressin 2 receptors** are responsible for limiting the amount of water released as urine. However, two other AVP receptors may be responsible for the way the human body responds to sugar intake. **Vasopressin 1a receptors** are located in the liver. When these receptors are activated, the liver increases its glucose production, potentially contributing to higher blood sugar after meals.

KIDNEY HEALTH

As with the relationship between water intake and urine production, there is a clear link between hydration and kidney health. Research has investigated the effect of water intake on the prevention of kidney stone formation. As more water is ingested, the amount of urine produced also increases. Some scientists have discovered that kidney stone formation decreases as urine volume increases. Therefore, increasing water intake could help reduce the chance of developing a kidney stone.

Chronic kidney disease (CKD) is characterized by gradual decreased kidney function over a long period of time and is identified by measuring how well the kidneys filter blood in the body. Research has shown an association between water intake and CKD, where a higher incidence of CKD was found in individuals whose water intake was less than 2 L per day compared to those who ingested more than 4.3 L per day.

Studies have shown that urinary proteins, kidney blood flow, and hyperfiltration increase in response to elevated AVP. In a comprehensive review of literature investigating hydration and CKD progression, researchers concluded that increasing water intake could assist CKD patients.

DID YOU KNOW?

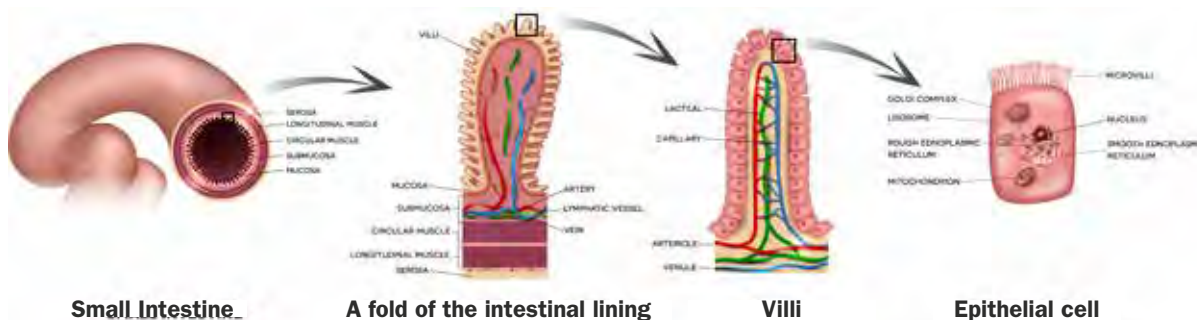
Did you know in 2015, a group of scientists performed a series of experiments in rats demonstrating the effect of water intake on glucose regulation? AVP was given to one group of rats for four weeks—representative of hormone responses to hypohydration in humans—while in the other group, water intake was increased. Rats in the AVP group had higher fasting blood sugar compared with the group that underwent increased water intake despite similar diets.

This same effect has also been tested in humans. In 2019, scientists infused highly concentrated water into participants' veins for two hours. This technique put the participants into a hormonal state, similar to what is experienced with hypohydration. After the concentrated water was infused, the researchers administered a test to measure how well the body controlled blood sugar. The amount of glucose in the participants' blood was significantly higher after infusion of concentrated water.

DIGESTION AND ABSORPTION OF WATER

Water is absorbed throughout the digestive tract but primarily in the small intestines. The concept of osmosis explains how the water crosses the cell membranes of the microvilli and enters the cells and bloodstream.

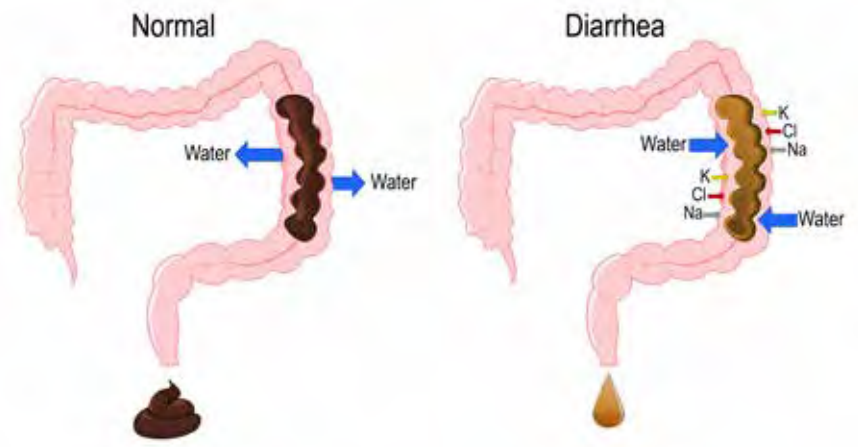
Figure 9.5 Structure of the Small Intestine.



The villi and microvilli offer a large surface area for diffusion of water in the small intestines.

The same process occurs in the large intestine as fecal matter is formed to create firm waste. The final absorption of water in the large intestines can be compromised if the junctions between the microvilli are loose and allow water to pass back into the lumen of the intestines or with noninfectious conditions like Crohn's disease or inflammatory bowel disease. Often, the leakage of water will be accompanied by sodium, potassium, and chloride along the gradient, leading to watery fecal matter.

Figure 9.6 Malabsorption of Water.



GASTRIC EMPTYING RATE:

The rate at which fluid is emptied from the stomach into the small intestine.

Water absorption is also influenced by the **gastric emptying rate**. Although gastric emptying varies by individual, the rate is influenced by several factors. Highly concentrated liquids will significantly slow down gastric emptying. For example, fluids with higher amounts of sugar or sodium will be emptied more slowly compared to plain water. The same effect occurs with high-energy-dense fluids or foods with large amounts of calories (macronutrients). Exercise is also a factor that slows down gastric emptying. While exercising in the heat, the human body relies on total body water stores for regulation of body temperature. The total fluid volume in the stomach also has an effect. Higher ingested volumes of fluid will be emptied more quickly into the small intestine. Upon initial entrance of a high volume of fluid to the stomach, gastric emptying will occur quickly, but as the volume within the stomach decreases, the gastric emptying rate will slow.

HYDROSTATIC PRESSURES:

The pressure exerted by a fluid at equilibrium due to the forces of gravity.

Once the fluid is emptied from the stomach into the small intestine, it still needs to be absorbed. The effectiveness of absorption depends on osmotic and **hydrostatic pressures**. As the passive movement of water across the intestinal wall is largely osmotically driven, sodium plays a pivotal role in how the human body absorbs water.

DIETARY SOURCES OF WATER

Most of the total water intake comes from the ingestion of drinking water. However, other beverages contain high amounts of water and can significantly contribute to total water intake. Milk, coffee, and tea are almost purely water (99 percent), help contribute to total water intake, and can have a positive effect on hydration status.

Approximately 20 percent of total water intake comes from food. This may vary between different diets as fruits and vegetables tend to have higher water content compared to other food items. Although diet does partly contribute to adequate total water intake, drinking water should be the primary means to improve overall hydration.

Figure 9.7 Top Water-Rich Foods



*Broccoli - 92% Water | Watercress - 90% Water | Cucumbers - 96% Water | Tomatoes - 94% Water
Watermelon 96% - Water | Spinach - 92% Water | Carrots - 90% Water | Celery - 95% Water
Lettuce - 96% Water | Grapefruit - 90% Water*

RECOMMENDED DAILY WATER INTAKE

The National Academy of Medicine recommends adult men and women consume 3.7 and 2.7 L per day, respectively. This equates to approximately 125 ounces for men and 90 ounces for women. In contrast, the European Food Safety Authority recommends men and women consume 2.5 and 2.0 L per day, respectively. The values outlined by both organizations include drinking water intake, water intake from other beverages, and water intake from food. Since approximately 20 percent of water intake comes from food, water intake from drinking water and other beverages should be approximately 101 ounces for men and 68 ounces for women. Individual total water intake requirements vary greatly due to variables including but not limited to diet, sodium intake, environment, lifestyle, body size, and age.

HYDRATION AND ATHLETES

Consequences of hypohydration can be seen throughout all systems of the human body. Many athletes routinely arrive to competition in a hypohydrated state, which can be detrimental to their performance. During exercise and athletic events, there are multiple physiological systems requiring fluid delivery via blood in the cardiovascular system. These four systems include the following:

- The brain for delivery of oxygen and metabolic substrates
- The heart and lungs for distribution of blood and exchange of gases
- The skin for removing heat from the body
- The working muscles to deliver fuel and oxygen

When sweat volume is high, the resulting decreased blood volume can compromise the physiological systems. As an initial response, the body will provide blood to the brain, heart, and lungs and reduce the amount sent to the skin surface and working muscles. Therefore, fuel delivery to the working muscles and the transfer of heat to the skin surface are reduced, leading to decreased exercise performance by way of muscle fatigue, reduced proton clearance, and overheating.

CARDIAC OUTPUT:

The amount of blood per minute pumped by the heart.

STROKE VOLUME:

The amount of blood pumped by the heart with each heartbeat.

CARDIAC DRIFT:

A phenomenon in which heart rate increases as stroke volume decreases due to decreased blood volume.

HYPERTHERMIA:

Dangerously high body temperature as a result of the body producing more heat than it can disperse..

ENDURANCE PERFORMANCE

Research suggests that when total body water loss reaches 2 percent, prolonged aerobic performance is decreased. During exercise the cardiovascular system maintains **cardiac output** to meet the metabolic demands of exercise. To determine cardiac output, heart rate is multiplied by **stroke volume**. As sweat loss occurs during exercise, blood volume decreases as fluids needed for controlling body heat—sweat—are drawn from the intravascular space—that is, plasma. This leads to a decrease in stroke volume.

This represents a process known as **cardiac drift**, where heart rate increases as stroke volume decreases due to decreased blood volume. If proper hydration occurs to replace the loss of blood volume from sweating, cardiac drift can be reduced. Additionally, during steady state exercise in hot conditions, **hyperthermia** causes an additive increase in heart rate. When fluid is ingested to match the amount of fluid lost during exercise, cardiac drift is reduced in moderate and hot environments.

HYDRATION STRATEGIES BEFORE, DURING, AND AFTER EXERCISE

The goal of hydration before exercise or athletic performance should be to arrive in a euhydrated state, but many athletes arrive to athletic events in a state of hypohydration. Using the less clinical techniques of measuring hydration status, such as thirst, urine color, and urine volume, athletes can develop effective strategies for ensuring pre-exercise euhydration. Overhydration should be avoided, as this also poses a rare but potentially severe situation.

An effective strategy for ensuring euhydration during exercise uses change in body mass. Steps for estimating the amount of fluid needed during exercise or athletic performance include the following:

- 1 Measuring nude body weight in a euhydrated state
- 2 Carefully tracking the weight of all fluid and food intake during activity
- 3 Weighing any urine or fecal matter produced during the activity if possible
- 4 Removing any remaining sweat from the skin surface after exercise
- 5 Using the same scale, obtaining a second nude body weight

Using the information collected from the above steps, the amount of fluid needed during the activity performed can be estimated, assuming similar environmental conditions and exercise intensity.

First, the difference in baseline body weight and post-activity body weight should be obtained. After this difference is calculated, the weight of fluid and food intake and weight lost from urine and fecal matter can be factored in (1 mL of water is equal to 1 g). The remaining weight is approximately equal to the amount of fluid that should be added to the fluid ingested during the activity. There should be no gain in body weight during exercise in hot conditions. If this occurs, the amount of fluid ingested should be reduced, as this could lead to a potentially harmful condition.

Replacing fluids lost during exercise, or **rehydration**, helps to reduce recovery times as well as decrease postexercise fatigue. Rehydration of 150 percent of lost water is needed to effectively replace fluid lost during exercise. Additionally, food ingestion may help in rehydration after exercise, as the electrolyte content in meals—that is, sodium—will help retain fluid.

REHYDRATION:

Replacing fluids lost during activity.

THERMOREGULATION:

How organisms control core body temperature.

PRACTICING SAFE HYDRATION DURING EXERCISE

Thermoregulation describes how organisms control their core temperature. For exercise, optimal hydration status is one of many factors contributing to the prevention of heat illness in athletes performing in hot conditions. Severe heat illnesses such as heat stroke can be fatal, so athletes should be provided ample opportunity to hydrate appropriately during activity.

The cardiovascular system is largely responsible for thermoregulation during exercise, and the effectiveness of this system is greatly influenced by hydration status. Heat accumulation during exercise comes from the combination of internal heat production—for example, metabolism—and external heat sources—for example, the sun. The heat produced from metabolism is transported through the cardiovascular system to the surface of the skin. Heat is dissipated from the skin's surface when sweat is evaporated from the surface of the skin. When blood volume is reduced, thermoregulation is compromised, as there is not enough blood volume available to transport heat to the skin for evaporative heat loss to occur.

EXERCISE-ASSOCIATED HYPONATREMIA (EAH):

When plasma sodium levels fall below the normal range.

Another consideration for hydration during exercise is **exercise-associated hyponatremia (EAH)**. This condition occurs when plasma sodium levels fall below the normal range. Early symptoms of EAH can be associated with other conditions, making it hard to recognize in its early stages. Symptoms include bloating, headache, nausea, and vomiting. During severe hyponatremia, symptoms become more specific to EAH and include cerebral and pulmonary edema, leading to confusion, seizures, disorientation, and difficulty breathing. EAH is typically characterized by an increase in body weight during exercise. However, it can also occur when there is a significant loss of sodium and water as with sweat.

During severe EAH the movement of fluid into the cells substantially increases, which causes expansion. When this occurs in brain cells that are enclosed within the skull, pressure buildup occurs, leading to potentially fatal symptoms. This shift of fluid also occurs in lung cells, which can lead to pulmonary edema in severe cases.

There are several risk factors contributing to the development of EAH, one of which is drinking larger fluid amounts than what is lost through sweat and urine during exercise. For this reason, fluid ingestion during exercise should not exceed body-weight losses. As individuals exercise for prolonged periods and replace fluid losses with sodium-free fluid, plasma sodium will decrease as the fluid ingested does not help to replace solutes lost from sweat. The introduction of fluids with electrolytes is key to promoting fluid balance.

Characteristics of individuals' sweat rate and sodium content also play a role, as sodium content in sweat can vary widely. When an individual who has a high sodium content in sweat also has a high sweat rate, the amount of sodium lost during exercise may increase the individual's risk of developing EAH. Other risk factors include exercise duration and body size. Exercise time exceeding four hours is a significant factor in developing EAH. Individuals with a smaller body size have lower overall body water, which can put them at risk.

To avoid EAH, several strategies have been shown to be effective, including:

- Developing a hydration strategy during prolonged endurance events helps ensure fluid ingestion does not exceed body-weight losses. If a person is at a higher risk for EAH, drinking only when thirsty may compromise performance but will significantly reduce the risk of EAH.
- Heat acclimatization has been shown to decrease the amount of sodium lost in sweat.
- Increasing the amount of dietary sodium before and during events could reduce or delay the decrease in plasma sodium as seen with EAH.

PERFORMANCE SUPPLEMENTATION AND HYDRATION

Some supplements taken for activity and performance enhancement have been found to affect hydration, and this should be taken into consideration.

Caffeine is a common supplement ingested by athletes before and during performance events. Although the increase in performance from caffeine has been demonstrated, common misconceptions of the supplement suggest the **diuretic effect** of caffeine will significantly affect hydration status. Most research suggests caffeine ingested in small amounts—approximately 3 mg per kilogram of body weight—will not affect urine output or the effectiveness of rehydration. However, when caffeine content exceeds 6 mg per kilogram of body weight, a diuretic effect has been observed.

DIURETIC EFFECT:

Any effect from a physiological process leading to increased urine production.

Creatine is also a commonly used supplement that may potentially affect hydration status. The hypothetical mechanism explaining this potential effect includes muscle cell creatine as a further solute affecting the concentration balance between intracellular and extracellular compartments. Therefore, the amount of fluid available for nutrient delivery to working muscles and for thermoregulatory benefits would be limited. At recommended dosages, creatine remains a safe supplement and does not significantly affect hydration status.



THE ROLE OF THE NUTRITION COACH

LEARNING OBJECTIVES

- 1 | Define the job description of a nutrition coach.
- 2 | Differentiate between a nutrition coach and a licensed professional.
- 3 | Understand best practices for referring clients to medical professionals.
- 4 | Summarize the qualities of an effective nutrition coach.
- 5 | Explain the Health Insurance Portability and Accountability Act (HIPAA).

It is estimated that five million people will go on a restricted meal plan this year, spending \$33 billion on weight-loss products, and at some point within the year, 80 percent of Americans will make some attempt to lose weight. Most will do this with dietary adjustments such as reducing or restricting calories or introducing supplements to expedite the process.

The most common culprit of positive energy balance leading to weight gain is excess calorie intake, and nutrient shortfalls often contribute as well. Most Americans have been found to lack vitamin D, calcium, potassium, fiber, and nutrient-dense vegetables in their diets, which can lead to inefficient body processes and an increased risk of chronic disease.

Table 10.1 Common Nutrients Lacking in the Diet.

NUTRIENT	USES IN THE BODY
Vitamin D	Bone health and calcium absorption
Calcium	Bone health and biological functions (muscle contraction, nerve transmission, and blood vessel health)
Potassium	Blood pressure control and kidney health
Fiber	Digestive health and reduced risk of cardiovascular disease and diabetes

With all the advice, information, and resources available regarding diet, nutrients, fitness, and health, it can be difficult for most people to find advice that is best for them. A nutrition coach is a trusted, well-educated resource for dietary guidance and promoting a healthy lifestyle over the entire life span.

WHAT IS NUTRITION COACHING?

Not only does a nutrition coach act as a knowledgeable guide through information, resources, and facts about nutrition, but they also help clients apply the information to their lives and health situations. Each client, their health status, and their goals are unique, and a nutrition coach can tailor nutrition plans to meet their individual needs. A nutrition coach also helps the client apply the information to their lives in a way that is practical, safe, and easy to follow. What is required is not simply changing eating habits but rather modifying behavior, and this is often overlooked when attempting to achieve nutrition goals. This may include the way individuals think about food, the function of food in their lives, their attitudes toward specific types of food, and their relationships with food in general.



Nutrition coaching empowers clients to take responsibility for their own health by providing resources and nutritional advice as well as coaching the non-dietary aspects of their lifestyle. These can include behavior patterns, well-rounded eating habits, and overall healthy lifestyles leading to total well-being. The goal of a nutrition coach is to teach clients how to be successful and self-sufficient. However, the scope of practice for a nutrition coach limits services provided to protect the professional and ensure proper medical care for clients as needed.

SCOPE OF PRACTICE

It is likely a nutrition coach will find themselves working with a diverse population of clients, some with preexisting health conditions. The nutrition coach will often assist clients struggling with obesity, **food addiction**, eating disorders, food allergies, and medical conditions that are influenced by their diets. Athletes, youth, and seniors are also common populations seeking the guidance of a nutrition coach.

It is important for a nutrition coach to understand obesity, eating disorders, food addictions, and common medical conditions that are affected by diet, but it is also essential that they understand what their **scope of practice** is when working with these clients. The scope of practice for a nutrition coach is limited by state and federal laws and what they allow a health care practitioner to do, given their education and experience. The laws in place are designed to protect both the professional from overreaching and the client from harmful advice. The aim of organizations such as the **Academy of Nutrition and Dietetics** is to allow consumers

FOOD ADDICTION:

A chronic disease characterized by an individual seeking food in a compulsive, difficult-to-control manner.

SCOPE OF PRACTICE:

The procedures, actions, and processes that a health care practitioner is permitted to undertake in keeping with the terms of their professional license.

ACADEMY OF NUTRITION AND DIETETICS:

The largest organization of food and nutrition professionals promoting the field through research, education, and advocacy.

to identify and access qualified professionals with appropriate knowledge and competencies to provide safe and ethical nutritional advice. Licensure is required for dietitians and licensed nutritionists, whereas most nutrition coaches require an educational certification or credential.

DID YOU KNOW?

A licensed nutritionist has earned a credential from a nationally recognized nutrition-licensing institution? These include the Commission on Dietetic Registration (CDR) of the Academy of Nutrition and Dietetics, the Board for Certification of Nutrition Specialists, and the Clinical Nutrition Certification Board. Licensed nutritionists are regulated by their certification board as well as by the laws of the state in which they practice.

Licensed nutritionists and dietitians

- Evaluate clients' nutritional needs,
- Provide nutritional counseling and advice to clients,
- Create clinical nutrition treatment plans for clients,
- Educate the public on nutrition issues,
- Research the effects of nutrition on health and fitness, and
- Consult with a team of health care practitioners on nutritional management for clients.

To become a registered dietitian, one must acquire a bachelor's degree from an approved supervised clinical program, successfully pass the CDR examination, and complete continuing education requirements to maintain registration.

Like licensed nutritionists, registered dietitians may work in a variety of settings, including the following:

- | | |
|---|-------------------------------|
| • Schools | • Food and nutrition industry |
| • Long-term care facilities | • Sports nutrition programs |
| • Hospitals | • Businesses |
| • Community or public health facilities | • Research facilities |
| • Corporate nutrition programs | |

Each state and province in North America has different rules for providing nutrition advice. In most states it is well within the scope of practice for nutrition coaches and personal trainers who possess fundamental nutrition knowledge to address questions and concerns their clients may have. However, offering medical nutrition therapy, such as meal planning or prescribing nutrition for a variety of health conditions and illnesses, is different. For example, certain states have statutes regulating the scope of practice for nutrition coaches and personal trainers who desire to provide nutritional guidance for their clients. Within these states the performance of medical nutrition therapy is illegal without first obtaining the dietitian credential and receiving licensure from the state.

The only states that currently do not have legal limitations on nutrition coaching or nutritionists—title or scope—are Arizona and Michigan. In these states it is legal for a nutrition coach or personal trainer to make nutritional suggestions for healthy, active individuals. It is also legal for anyone to share nutrition education through materials originating from a public or well-known entity such as the American Heart Association, the Centers for Disease Control and Prevention, the American College of Nutrition, ISSA, and so on. However, it is illegal to prescribe nutrition for medical conditions, unless the professional is a licensed dietitian. All other states and Puerto Rico have protections regulating the dietetics profession and associated titles or require certification or licensure for dietitians using the titles “nutritionist” or “dietician.”

The Academy of Nutrition and Dietetics provides a current list of states, statutes, and regulations on its webpage: <https://www.cdrnet.org/state-licensure>.

Ultimately, the scope of practice of a nutrition coach allows them to provide nutrition advice and information to healthy individuals, to answer general questions regarding nutrition, and to create a plan with their clients to reach their nutrition goals. It does not allow them to diagnose, treat, or prescribe nutrition for illnesses of health conditions or use the titles “licensed dietitian” or “certified nutritionist.” Lastly, while the scope of practice of a nutrition coach allows them to work alongside a medical professional—following their advice and prescriptions—to help their client achieve their nutrition and health goals, it does not allow them to prescribe medical nutrition therapy.

It is important to understand the difference between general nutrition suggestions and **medical nutrition therapy** so a nutrition coach can stay within their scope of practice. Recommending specific breakfast foods for general good health for a type 2 diabetic is within the scope of practice. However, recommending the same breakfast foods for controlling blood sugar is beyond the scope of the nutrition coach’s practice—and likely expertise—and goes against the regulations of many states.

MEDICAL NUTRITION THERAPY:

Treating medical conditions with diet.

To remain safely within state guidelines, nutritionist coaches with nutrition certifications and continuing education credits often make suggestions related to optimal rest, hydration, and food intake. Such topics directly relate to gym performance and usually include recommendations for the following:

- Adequate sleep
- Adequate hydration
- Pre-workout nutrition
- Post-workout nutrition

They may offer ideas or education on the following topics:

- Calorie management strategies: eating less, eating more filling foods, avoiding calorie-dense drinks and snacks, and so on
- Food selection strategies: choosing whole grains over processed carbs, choosing complete protein sources, choosing water over soft drinks, and similar
- Food timing strategies: eating in and around the workout, eating breakfast, not eating a large meal right before bed, and so on
- Healthy lifestyle choices: meal options for breakfast, lunch, and dinner; alternative snack suggestions; and planning for upcoming social events

It is important for the nutrition coach to recognize nutritional issues that fall outside the scope of practice so they can identify when and whom to refer the client to. For example, giving nutrition advice for health problems such as diabetes, heart disease, eating disorders, and so on is the domain of registered dietitians and medical practitioners.

Nutrition coach DOs:
Provide general nutrition information such as the role of fats, carbohydrates, and proteins or healthy sources of carbohydrates, proteins, or fats
Share research regarding absorption, effect, or use of macronutrients or micronutrients for normal, healthy individuals
Discuss information, advice, tips, or research about effective behavioral change strategies to reach nutrition goals

Nutrition coach DON'Ts:
Diagnose, treat, or give advice regarding medical nutrition needs
Offer treatment advice for medical conditions
Offer treatment advice for any mental health condition or eating disorder
Discuss personal relationships, career, or life advice

REFERRING CLIENTS

Creating a referral network is a key step for a successful nutrition coach. It is also important to identify professionals who complement the service offerings of a nutrition coach, such as a chiropractor, physician, massage therapist, registered dietitian, or psychologist in the localities served. As the relationships are established, the nutrition coach is obligated to conduct due diligence research into the qualifications and licensure status of any professional in a referral network. This is not only for confidence in the affiliation but also to ensure that clients understand who they are being referred to for additional assistance.

Table 10.2 Common Health Conditions and Referrals.

CONDITION	LICENSED PROFESSIONAL FOR REFERRAL
Disordered eating	Therapist, psychologist, and clinical social worker who specializes in eating disorders
Digestive issues	Gastroenterologist
High blood pressure	Physician or cardiologist
Food allergies	Allergist or physician
Diabetes	Endocrinologist
Thyroid issues	Endocrinologist
Sinus issues	Physician or ear, nose, and throat specialist

DID YOU KNOW?

There are many types of licensed nutritionists? Some types include the following:

- Clinical nutritionist: works in medical and long-term health care facilities
- Public health nutritionist: works in community and government organizations
- Management nutritionist: works in medical facilities and institutions planning meals and consulting on dietary needs
- Nutritional consultant: works in private practice and provides nutritional information to others through counseling, educational seminars, and working with corporations
- Sports nutritionist: works with clients in athletic settings such as fitness centers, gyms, and sports medicine clinics
- Animal nutritionist: works with the dietary needs of animals, in research, and for pet food companies, zoos, and veterinarians

There are also many types of registered dietitians:

- Clinical dietitians are specifically trained to provide medical nutrition therapy in settings such as hospitals and long-term care facilities.
- Community dietitians educate the public on food and nutrition issues and topics. They may also work in government agencies, nonprofit organizations, public health clinics, and health maintenance organizations.
- Management dietitians plan meals in food service settings, including hospitals, cafeterias, and food corporations; oversee other dietitians, kitchen staff, and food purchases; and perform the business tasks of managing a meal program.

While building relationships with different professionals, one may find these professionals refer their clients for nutrition-coaching services. A nutrition coach can market their services to these professionals as they would a new client to generate excitement and remain relevant. It is important to work with each referred professional to develop a mutually beneficial referral partnership. Over time, referrals from medical professionals, other specialized nutrition coaches, and current clients can become a large part of new business.

QUALITIES OF AN EFFECTIVE NUTRITION COACH

Nutrition coaches have a unique opportunity to affect the nutritional habits of clients as well as their overall lifestyle choices with a well-rounded, inclusive approach. For many people, an effective nutrition coach can be the difference between health and weight loss success and health and weight loss failure. There are several qualities that can help an efficient nutrition coach be successful:

- Being educated
- Working within the scope of practice
- Meeting clients' needs
- Assessing clients accurately
- Building rapport
- Motivating others
- Setting appropriate goals
- Gaining commitment
- Building mental toughness
- Referring clients appropriately
- Being professional

QUALITY AND CURRENT EDUCATION

All professions require some level of education and training, and nutrition coaching is no different. Being an effective nutrition coach begins with earning a quality education about all aspects of nutrition and lifestyle change. It also means staying abreast of the latest research and information regarding the field of nutrition and how it applies to the needs of a client. Coaches can attend seminars, read books and scientific journals, take additional courses or certifications, and find a niche such as working with youth or specializing in sports nutrition.

WORKING WITHIN THE SCOPE OF PRACTICE

To be effective a nutrition coach must always be aware of the lines governing scope of practice. Attempting to work outside the scope of practice is not only detrimental to the client, but it also undermines the true value of nutrition coaching and the medical professionals qualified to assist people. Nutrition coaches are most effective when they focus only on providing valuable, evidence-based nutrition and lifestyle information to the client, abiding by any guidelines or advice set forth by the client's medical providers, and offering effective strategies and techniques to change eating habits and behavior.

MEETING CLIENT NEEDS

Just as clients are different in terms of shape, size, and life experiences, nutrition coaches vary as well. While some may be more experienced with marathon runners, others may have

spent years training with bodybuilders or working in residential treatment facilities for patients with eating disorders. The result is that every nutrition coach has specific knowledge, skills, and abilities that are helpful to some clients but may not be helpful to others. The best nutrition coaches are those who can match their knowledge, skills, and abilities to the needs of their client.

MOTIVATIONAL INTERVIEWING:

A counseling approach used to elicit behavior change through resolving ambivalence.

For example, a client who is struggling with motivation to make changes in eating habits and is battling with self-doubt after many failed attempts may be best helped by a nutrition coach who is knowledgeable in **motivational interviewing**. A nutrition coach who is unfamiliar with this technique may be well suited to continue their education by reading more about it and expanding their knowledge.

Motivational interviewing follows five basic steps or principles:

RESIST telling, convincing, or directing a client about the “right path”

UNDERSTAND their values, abilities, needs, motivations, and potential barriers to behavior change

LISTEN with empathy and understand their perspectives

EMPOWER them to set achievable goals and provide techniques to help them do so

ENCOURAGE autonomy and self-sufficiency

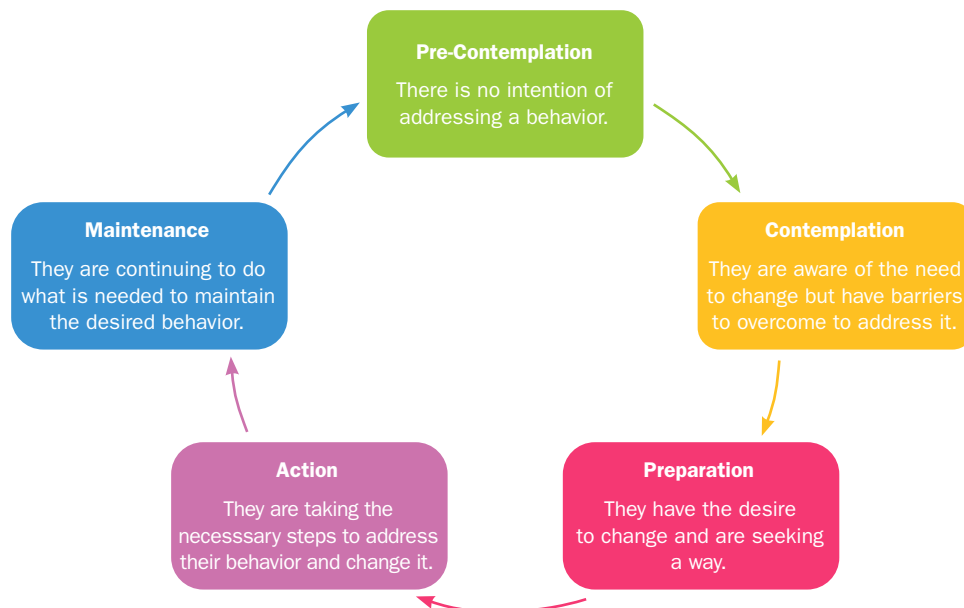
ASSESSING ACCURATELY

Some clients are ready to change, while other clients have thought about change for a long time yet have not taken the steps. The **stages of change** determine a client’s readiness to adjust their current habits to achieve a different outcome. To be effective with a variety of clients, the nutrition coach must be able to accurately assess the stage of change the client is in and match the intervention used to that stage of change.

STAGES OF CHANGE:

The dynamic phases of the behavior change process.

Figure 10.1 The Five Stages of Change.



For example, a client in the action stage may be helped by discussing specific strategies to make the desired changes easier to perform and maintain, while a client who is contemplating change would be better helped by weighing the costs and benefits of the desired change. Nutrition coaches who can recognize a specific stage of change and are familiar with the strategies and techniques that are most effective for that stage are typically more effective with their clients and are often received better by them.

The physical and emotional conditions of a client will also have a lot to do with their success. While some clients struggle with medical nutritional conditions, others may struggle with relationship conflicts that complicate their progress within a coaching program. To be most effective, it is essential that the nutrition coach knows how to recognize the variety of issues clients may present with, such as obesity, eating disorders, or Crohn's disease, and understand when a referral to a medical professional is warranted. The effectiveness of a nutrition coach will always be limited by the client's untreated issues, and the best nutrition coaches are those who can recognize the client's needs and refer the right treatment providers for them. When this is done effectively, the nutrition coach can focus solely on their role of providing the client with the most applicable nutrition information and techniques to achieve their goals.

RAPPORT:

A close, harmonious relationship where feelings and ideas are communicated effectively.

BUILDING RAPPORT

Any client seeking the help of a professional is most likely seeking a level of comfort and trust with the individual(s). Without trust the efficacy of treatment is reduced and can deter the professional relationship. This relationship, or **rapport**, is based on a mutual feeling of trust and genuine concern and empathy. The most effective nutrition coaches understand that success with any client begins and ends with the rapport they develop and maintain. By showing authentic concern for their clients, trying to understand and relate to their client's experience, and offering them the knowledge, skills, and abilities that they believe will best help them, the nutrition coach can encourage self-sufficiency and confidence.

MOTIVATION:

Someone's reason for acting or behaving in a particular way.

MOTIVATING OTHERS

Motivation describes someone's reason for acting or behaving in a particular way and is important to identify for anyone contemplating or making a change. For many people, food is more than nutrition; food is comfort, it eases stress and anxiety, or it allows them to be more social. For clients who want to make nutritional and lifestyle changes, a coach must understand their client's reasons—their why. Without defined motivation, change is unlikely to occur no matter how clear the path.

A nutrition coach is also tasked with keeping clients connected to their own personal motivations throughout the process to prevent or minimize regressions.

SMART GOALS:

Specific, measurable, attainable, realistic, and timely outcomes for an individual to work toward in a stepwise manner.

SETTING GOALS APPROPRIATELY

SMART goals are specific, measurable, attainable, realistic, and timely and will ensure a client has a clear plan of action. Goals must be SMART and align with the appropriate stage of change a client is in. It is possible for a client to have multiple goals, and it is the nutrition coach's job to effectively help them prioritize the goals for maximum success. There is a difference between arbitrarily setting goals that are not appropriate for a client and **client-appropriate goals**. Goals that are appropriate to the client align with their values, beliefs, and motivations. Setting goals with the client, using what is important to them as a guiding feature, and then working with them to design steps that help them reach these goals are fundamental roles of an effective nutrition coach.

CLIENT-APPROPRIATE GOALS:

Goals aligning with the client's values, beliefs, and motivations.

FIGURE 10.2 SMART GOALS.

GAINING COMMITMENT

Lasting lifestyle changes are difficult to make and can be complicated by external and internal influence. **Commitment** is the quality of being dedicated to a cause or goal, and it can be challenging to gain when it comes to the stages of change. A nutrition professional who gains the commitment of a client can hold them accountable to their progress and goals as well as drive the process and timeline through which they work. A **commitment strategy** is a way to gain leverage on oneself or others and make the desired changes. Effective coaches will have effective commitment strategies that work for each individual and keep clients on track toward their nutrition and lifestyle goals. The aim is to gain the client's full commitment as the goals can only be achieved by them and the effort they put into the process.

COMMITMENT:

The quality of being dedicated to a cause or goal.

COMMITMENT STRATEGY:

A way to gain leverage on oneself or others and make desired changes.

BUILDING MENTAL TOUGHNESS

Mental toughness, or grit, is a term used to describe the way a client approaches and responds to adversity and is closely related to the stages of change through the belief that building mental toughness has an end goal of self-efficacy and independence in thought and process. There will always be setbacks, plateaus, and issues arising in the life of a wellness or nutrition coach. Coaches can use many techniques to increase grit, including revisiting the client's motivations, reframing adversity as a necessary part of learning and an inevitable step in the process, and recognizing and celebrating progress and continued improvement. Mental toughness is an essential part of any change process, and effective nutrition coaches understand it and can help a client increase their resiliency.

MENTAL TOUGHNESS:

The ability to respond to adversity in a way that does not allow it to stop the progress toward one's goals.

REFERRING CLIENTS APPROPRIATELY

An effective nutrition coach must also know when to refer a client to the appropriate medical health care professional for additional assistance or treatment. To do so, coaches must foster and maintain a diverse network of medical providers. A client's progress in a nutrition-coaching program will always be limited by any untreated conditions, and when a nutrition coach fails to recognize these conditions or fails to respond effectively to them, progress can be stymied.

Referring a client does not mean they are lost to the nutrition coach. It does, however, show the nutrition professional's commitment to the overall process, success, and health and well-being of the client.

BEING REPUTABLE AND PROFESSIONAL

A nutritional coach should understand and use professional skills—for example, communication, phone etiquette, and industry relations—to build a reputable business and know how to effectively market their services. Nutritional coaches can be educated and experienced, yet when professionalism suffers, the success of their practice may suffer as well. One example is maintaining appropriate personal and professional boundaries with clients and their families. Without clear boundaries, trust can be destroyed, and a coach can jeopardize their reputation, career, and financial well-being should legal ramifications ensue.

The extensive use of social media for marketing is also a point of consideration for a nutrition coach. Professional business pages should be kept as such on all platforms. They are not a place for political or personal opinions or messages and should remain separate from a coach's personal profile to maintain that boundary. However, even on personal pages, nutrition coaches should consider the following questions before posting to ensure their business or reputation are not damaged or affected by social media posts or comments:

- Who can see the post or profile?
- Is the post an opinion or a professional statement?
- How is the message being presented?
- Is the message relevant to the business?
- Is the message being shared on the correct platform?

A nutrition coach should hold themselves accountable to the same standards of professionalism that a medical doctor or surgeon is held to for consistency and to protect themselves and clients. These attitudes and behaviors include accountability, motivation, empathy, integrity, and lifelong learning. A great slogan used by the Mayo Clinic reads: “Engendering trust by doing the right things, for the right reasons, in the right way, at the right time.”

ETHICAL CONSIDERATIONS OF A NUTRITION COACH

All health care providers, fitness and nutrition professionals, and mental health professionals have ethical and legal challenges to consider and be aware of in their practices. In 1999, the National Academy of Medicine published a comprehensive report on medical errors in the United States, resulting in sweeping reforms in the field of patient safety. The report determined ways to increase not only the physical safety of clients, like the state regulations on the field of nutrition, but also privacy rights.

CLIENT PRIVACY

Protecting a health or medical client's privacy means maintaining security and **confidentiality** of the client's records. This includes both the security measures taken to protect the physical client records and the discretion of health care providers themselves. Records must be stored in a safe and secure location with limited access to vetted individuals within the practice, and details from within client files cannot be shared with anyone other than the client without their express written consent. This includes spouses, insurance companies, third parties, or other medical professionals.

With the advent of electronic medical records, protecting **client privacy** has become a much larger concern. Electronic records are at risk of breach if they are not stored or handled appropriately. Emailing client files and accessing them online through unsecured portals and mobile devices are real dangers for a coach to consider.

HEALTH INSURANCE PORTABILITY AND ACCOUNTABILITY ACT

The **Health Insurance Portability and Accountability Act (HIPAA)** was enacted to protect clients' privacy and confidentiality. It applies to all health practitioners, including nutrition professionals, and establishes national standards for electronic health care transactions and records.

The following are the three central rules within HIPAA:

- Privacy rule: sets national standards for **protected health information (PHI)** and when it can be disclosed
- Breach notification rule: requires covered entities to notify affected individuals and the US Department of Health and Human Services in the event of a breach of PHI
- Security rule: specifies safeguards that covered entities and businesses must implement to protect confidentiality, integrity, and availability of electronic PHI

HIPAA laws must be followed by all health care practitioners, including doctors, clinics, hospitals, nursing homes, home health care providers, and pharmacies, as well as all health plans and health care clearing houses. HIPAA also applies to any business associates of third-party covered entities, such as those who perform certain functions, including claims processing, administration, storing or destroying records, lawyers, accountants, and IT specialists as well as any entities that transmit PHI, such as regional health information organizations. Lastly, HIPAA applies to all forms of individuals' protected health information, whether it be electronic, written, or oral.

CONFIDENTIALITY:

A set of rules governing the access to information discussed between a health care practitioner and their client.

CLIENT PRIVACY:

The practice of maintaining the security and confidentiality of the client's records.

HEALTH INSURANCE PORTABILITY AND ACCOUNTABILITY ACT (HIPAA):

Establishes national standards for electronic health care transactions and records to maintain confidentiality of health-related information.

PROTECTED HEALTH INFORMATION (PHI):

Client records including current or past medical conditions, payment details, or health care provisions.



A collage of food images including broccoli, tomatoes, a banana, a white vegetable, a burger, and chips.

CHAPTER 11

STAGES OF CHANGE AND MOTIVATIONAL INTERVIEWING

LEARNING OBJECTIVES

- 1 | Understand the five stages of change.
- 2 | Describe the three aspects of motivation.
- 3 | Explain motivational interviewing and how it applies to nutrition coaching.
- 4 | Recognize strategies that make motivational interviewing more effective

STAGES OF CHANGE:

The general steps for deciding to change, plan, and implement any type of behavior modification.

STAGES OF CHANGE MODEL:

The behavior change model used to describe the thoughts, feelings, and behaviors of people in the process of change.

STAGE MATCHED:

Interventions that are matched to the client's current stage of change.

AMBIVALENCE:

Having mixed feelings or contradictory ideas about something or someone.

RELAPSE:

Falling back into previous behavior patterns.

Making changes or adjustments to behaviors or lifestyle patterns can be a difficult task. Each individual will go through the process at their own pace and with their own setbacks and successes. The **stages of change** define the general steps for deciding to change, plan, and implement any type of behavior modification. Originally developed in the 1970s by James O. Prochaska and colleagues, the **stages of change model** is used to describe the thoughts, feelings, and behaviors of people in the process of change. The model outlines and clarifies the motivational conflicts people experience when making a change and is laid out to highlight the cyclical nature of the process. When interventions and therapies can be **stage matched** and are applicable to the stage of change a client is currently in, the interventions are typically more successful. These principles apply to psychological interventions as well as nutrition and dietary interventions in the health and wellness field.

The motivations of an individual detail their reasons for behaving in a specific manner. The client's intentions must be clearly defined and understood by both the client and the nutrition coach to ensure the program is appropriate. A process called motivational interviewing seeks to elicit behavior change while resolving **ambivalence**—having mixed feelings or contradictory ideas about something—for optimal results.

THE STAGES OF CHANGE MODEL

The stages of change model describes the stage of behavior change an individual is in at any given time and recognizes the following factors as necessary for behavior modification:

- 1 An increased awareness of the decision balance—the advantages (pros) of changing outweigh the disadvantages (cons)
- 2 Self-efficacy and autonomy—the ability to act independently to make choices
- 3 Strategies to make and maintain change—the avoidance of **relapse**

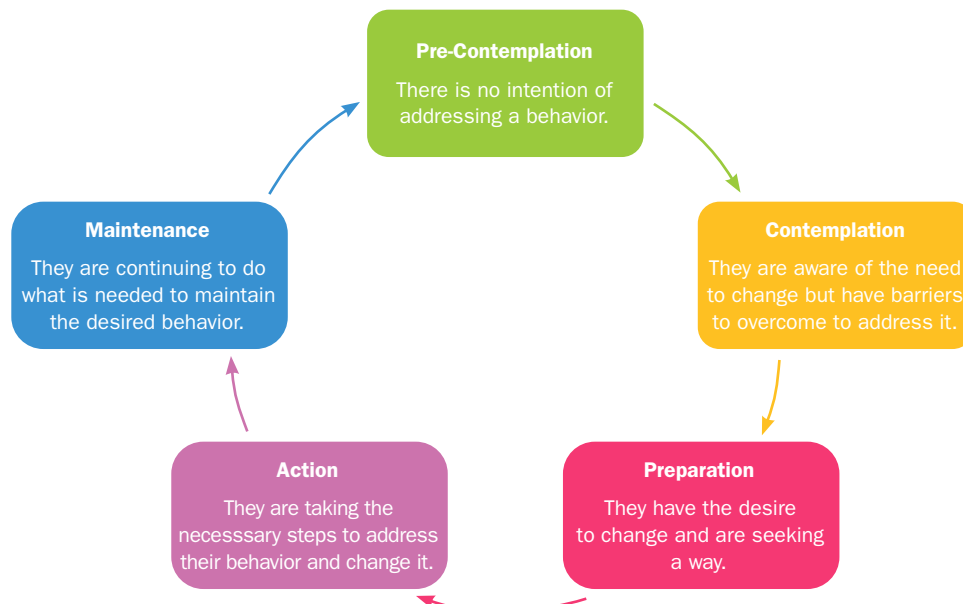


DID YOU KNOW?

The stages of change model describes 10 processes of change:

- 1 **Consciousness raising** - increasing awareness of the benefits of change and the risks of not changing
- 2 **Dramatic relief** - relief from aversive feelings about their behavior and feelings of hope when seeing other people in similar situations change
- 3 **Self-reevaluation** - the recognition that healthy behavior is an important part of who they are and want to be
- 4 **Environmental reevaluation** - the recognition that their unhealthy behavior has negative effects for others around them
- 5 **Social liberation** - feeling supported socially in making change
- 6 **Self-liberation** - feeling confident in one's ability to change and liberated from the negative effects of not changing
- 7 **Helping relationships** - feeling supported by others in changing
- 8 **Counterconditioning** - conditioning healthy behaviors and replacing unhealthy ones
- 9 **Reinforcement management** - associating positive rewards with healthy behaviors and reducing rewards from unhealthy behaviors
- 10 **Stimulus control** - learning to control environmental triggers to promote healthy behavior and reduce unhealthy behavior

Figure 11.1 The Stages of Change.



STAGE 1: PRE-CONTEMPLATION (NOT READY)

People in this stage may not be consciously aware of the risks of their behavior, or they minimize concern about the risks and have no intention to change behaviors. In some cases, they may not be aware that a problem exists in their behavior. It is not uncommon for clients to say things like, “I don’t see anything wrong with what I do, but my wife told me to come here,” or “I think I’m fine, but my doctor said I should see you.” An important indicator of the pre-contemplation stage is that the decisional balance doesn’t support change (people see more cons than pros), and those in this stage may not feel a high sense of self-efficacy about making change.

PRE-CONTEMPLATION

There is no intention of addressing a behavior.

To help them move toward change, the decisional balance needs to be shifted (where the benefits outweigh the cons) to support change. A coach can ask a client about their perception of their behavior and the negative effects it may be having on their life or the lives of others through the use of questions such as these:

- Describe how your unhealthy behavior affects you on a daily, weekly, and monthly basis. What long-term outcomes do you think your behavior will lead to?
- In what ways might your behavior be affecting those around you? What is your perception of the healthy behavior that you are considering? (The coach can encourage them to educate themselves.)
- Do you have a desire to become more educated about _____ behavior?

Change can be achieved only through a shift in a client’s perception of the change. To support the client’s perception, a nutrition coach should ask their client to do the following:

- Rate their confidence in their ability to change
- Determine what steps can be taken to raise their confidence
- Determine what barriers they are encountering
- Define what makes change difficult to them

STAGE 2: CONTEMPLATION (GETTING READY)

When the decision balance is equal, a client will see the cons as equal to the pros regarding making a behavior modification. Often this causes a stalemate where change behavior is put off for some time, there is a high degree of ambivalence, and self-efficacy is not quite developed. People at this stage will often say things like, “I know I will feel better if I lose weight, but I just don’t know if I can,” or “I know I will be happier if I start working out, but I’m not sure I can fit it in.”

CONTEMPLATION

They are aware of the need to change but have barriers to overcome to address it.

In the contemplation stage, the decisional balance is at a deadlock, and there is a high degree of ambivalence about the ability to change. For this reason, it can be very helpful to heighten the awareness of the benefits of taking the next step and make efforts to raise self-efficacy. A nutrition coach may draw a client’s attention to additional benefits of changing that they might have overlooked or ways their life may be better, which can be very helpful in this stage through the use of questions such as these:

- In what ways might your relationships improve if you made a change?
- In what ways might your work life (or productivity) improve if you changed?
- In what ways would you see yourself differently if you changed?

Additionally, a nutrition coach can draw attention to other successes a client has had in the past and their ability to successfully make behavior modifications by asking questions like these:

- Can you tell me of times in the past when you have been able to make positive changes?
- What other challenges have you been able to overcome?
- How did you manage those changes?

It can also be helpful to have a client make a list of the skills and abilities that will help them be successful in making a change.

STAGE 3: PREPARATION (READY)

People in the preparation stage are ready to take action. They see the pros as greater than the cons, and decisional balance has shifted in favor of change. Here, people will often begin to plan and initiate small steps toward change; however, there is still some self-doubt about their success as self-efficacy may remain low. Those in the preparation stage will often say things like, “I am going to start working out three times a week, starting next week, but I’m still not sure how I will fit everything in,” or “I am planning to eat low carb moving forward, but I don’t know what I will order when I eat out with friends.”

PREPARATION

They have the desire to change and are seeking a way.

To motivate and support, a nutrition coach must focus on self-efficacy and confidence in this stage of change. Addressing the fears associated with failing (instead of avoiding them) can help clients overcome self-doubt. The coach can ask questions such as these: What is your attitude toward failing?

- Can you learn from failing?
- Does failing mean that you cannot try again?
- If you fail one time at this change, does that mean you have failed altogether?

These can help a client begin to reframe any potential failure as a normal part of the learning process. Additionally, efforts to help build a client’s social support network can be effective in helping them feel supported and confident about change. An effective strategy a coach can use is to ask a client to make a list of their supporters and inform them of the client’s goals and ways in which they can support the client in making changes. Last, the coach can address situations in which the client is likely to give in to impulses, have trouble maintaining change, or relapse to unhealthy behaviors, which can help them overcome fears about not being able to maintain their new behavior.

STAGE 4: ACTION

The action stage is characterized by measurable steps toward changing one’s behavior through conscious effort for up to six months. In this stage, people value the pros of changing more than the cons, which further shifts the decisional balance positive. Self-efficacy is also increased as positive and measurable changes have been made, and there is a greater

sense of confidence. In this stage people often say things like, “I’m really happy that I’ve been able to maintain my diet for the past few weeks; I just hope I can keep it up,” or “I can see my body changing, and I like it, but I hope I don’t plateau.”

ACTION

They are taking the necessary steps to address their behavior and change it.

While people at the action stage have increased levels of self-efficacy and now see the benefits of changing as much greater than not changing, the novelty of the new behavior will begin to wear off. For this reason, focusing on commitment strategies to maintain change can be useful in overcoming the urge to slip back to unhealthy behavior. To help maintain a client’s motivation and sustain progress, a coach can teach client techniques that use incentives and penalties to maintain change, focusing on strategies such as avoiding the unhealthy section of the grocery store, removing unhealthy food from the home, using text reminders of the benefits of an activity while performing it, and increasing awareness of the positive feelings associated with exercise. Further, a coach can ask questions such as these: In what ways do you feel more confident now that you have changed?

- What do you feel like you are really getting good at?
- What steps have you taken on your own (or come up with) to help keep your change going?
- Can you describe any underlying or deeper reason for this change? These can help increase a client’s awareness of their sense of mastery, autonomy, and purpose—the three drivers of motivation—in changing behavior.

STAGE 5: MAINTENANCE

People in the maintenance stage have maintained their positive changes for more than six months. They feel greater confidence about themselves and consistently rate the pros of change as greater than the cons. Here behavior is more stable, and people are much more likely to continue toward healthy behavior in the long term. It should be noted, however, that people in the maintenance stage can still relapse toward unhealthy behavior when in stressful or triggering situations. They may say things like, “I really feeling confident with my weight now, and I’m wondering if I can start eating some of the things I used to really like,” or “I thought because I’ve been doing so well in my exercise, I could take a few days off.”

MAINTENANCE

They are continuing to do what is needed to maintain the desired behavior.

In the maintenance stage, as people have overcome some obstacles on their path toward change, they often feel a greater sense of confidence in their ability, and there is greater consistency in their positive behavior. While the benefits of change have now been experienced and enjoyed, stressful situations can continue to put them at risk for relapse to unhealthy behavior. Therefore, it can be very helpful to address any stressors (or triggers) and develop a strategy to manage stress in a positive way. The coach can ask questions such as these: Who can you turn to for support when in a stressful situation?

- What is your attitude toward stress?
- Can stress be used in a positive way?
- What are three things you can do to respond to stress in a positive way (as opposed to reacting in a way that might hurt yourself or others)?
- What skills do you have that help you deal with stress?
- What skills can you learn to help you better manage stress?

These can draw a client's attention to the ways in which they can change their perception and response to stress. To help maintain change, it can be especially effective to encourage clients to engage in ongoing social support. To best provide support, a coach should ask the following questions:

- Who most supports you in your healthy behavior?
- Who motivates you to continue being healthy?
- Who do you (or can you) share your healthy experiences with?
- Are there any accomplishments you would like to take on now that you are healthier (such as running a marathon, doing a bike ride, or learning a new sport)?

DETERMINING MOTIVATION

The language clients use to answer questions throughout the process can provide valuable insight to a nutrition coach when attempting to establish motivation. **Open-ended questions** can be helpful in expanding the conversation about change and help to reveal the stage of change a client is presently in. This type of question requires more than a yes or no answer and forces the client to probe deeper. A coach can also use the following more specific questions to assess the stage of change and discover motivation:

OPEN-ENDED QUESTIONS:

Probing questions that require more than a yes or no response.

- What are your thoughts about making this change?
- Is there anything specific that motivated you to make a change?
- How would you describe the benefits of making a change?
- How would you describe the costs of making the change?
- On a scale of 1–10, how confident are you in your ability to make the change—1 meaning “not at all” and 10 meaning “I’m fully prepared”?
- On a scale of 1–10, how strong are the factors that may derail your change—1 meaning “they will not affect me” and 10 meaning “I cannot control my reaction to these factors”?
- At this point, have you made plans to change?
- Have you taken any measurable steps toward changing?
- If you haven’t taken any steps toward change, do you plan to in the next six months?

THE ELEMENTS OF MOTIVATION

Motivation, the reason people behave the way they do, is composed of three key elements: autonomy, mastery, and purpose. Within the stages of change, each element of motivation is important and must be achieved to reach maintenance. A nutrition coach should understand each of these elements to successfully progress clients through the stages of changing their behavior within a coaching program for the following reasons:

- When people are given the autonomy and have confidence, motivation increases.
- When people can achieve mastery over what they are doing, motivation increases.
- When people have a deeper sense of purpose for the things they do, they are much more motivated to do them.

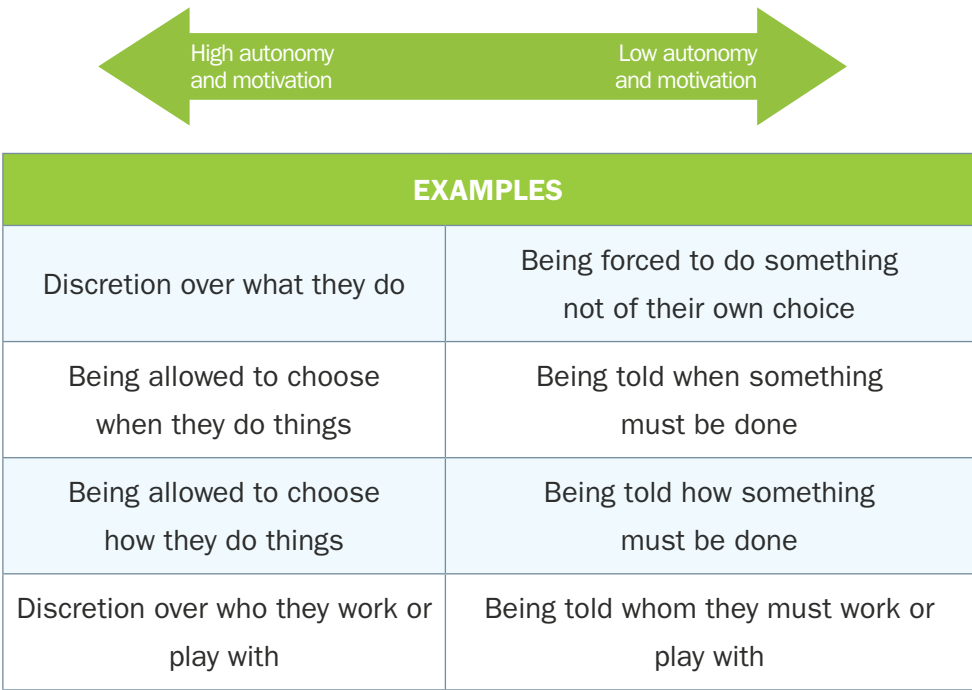
AUTONOMY

Autonomy describes the ability to self-govern and the capacity to act in accordance with objective guidelines instead of being influenced by desires and whims. Someone with fully developed autonomy is independent in their thoughts and actions and makes their own decisions.

Autonomy versus Motivation

There is a distinct relationship between autonomy and motivation that a nutrition coach must understand and teach to their clients. As autonomy increases, motivation increases, and as autonomy is diminished, motivation declines.

Figure 11.2 Autonomy and Motivation Spectrum.



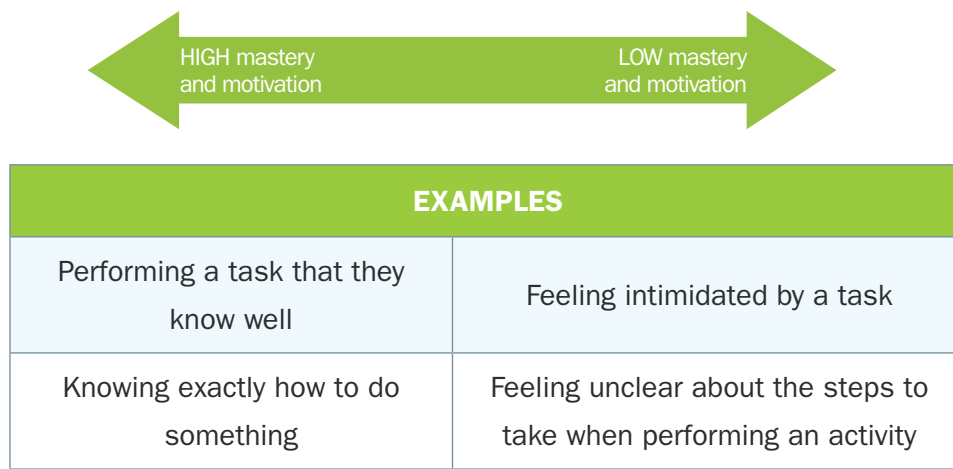
MASTERY

Mastery describes the state of having complete understanding and knowledge of a subject or situation. When people feel they are educated, confidence is increased and successful behavior modification and maintenance can be achieved.

Mastery versus Motivation

Like autonomy, mastery exists on a sliding scale and is constantly changing. The relationship of mastery to education also means that clients and coaches must continue to learn and keep up with changes and research that may affect their present knowledge levels. As mastery levels decrease, research has shown a deleterious effect on motivation levels.

Figure 11.3 Mastery and Motivation.



PURPOSE

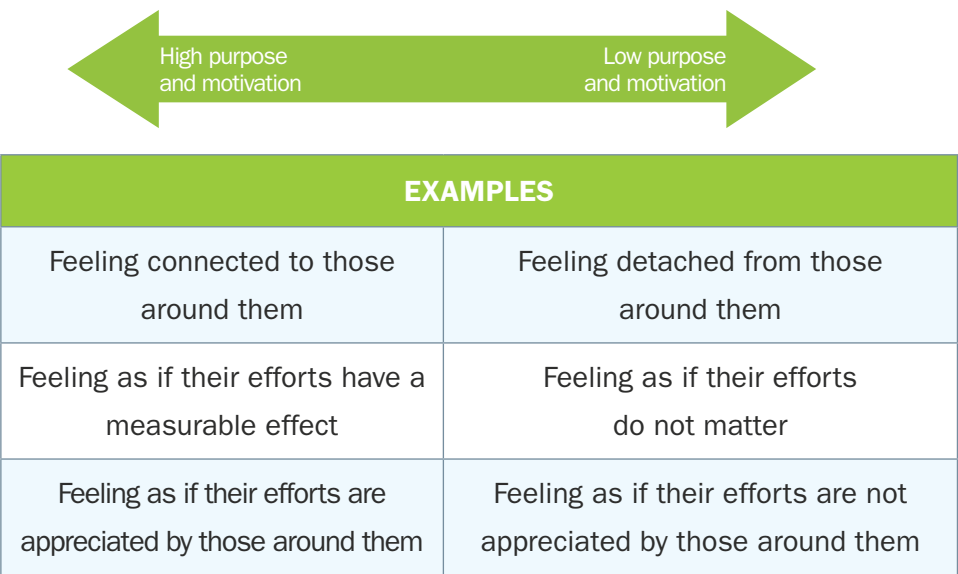
Purpose is defined as an individual's goal or fixed intention, and it ties deeply into motivation. Everyone has a reason for doing something, including making a change. If a nutrition coach can dig deep enough to determine a client's purpose, they can unlock their true motivations and better progress them through their behavior modification.

Purpose versus Motivation

It is important that the client understand that as sense of purpose increases, motivation increases as well, and lacking purpose, motivation suffers much like autonomy and mastery. It is a relationship that is ever changing and, again, is on a sliding scale.



Figure 11.4 Purpose and Motivation.



MOTIVATIONAL INTERVIEWING

The motivational interviewing (MI) model is a widely accepted approach to elicit behavior change. Developed by clinical psychologists William R. Miller and Stephen Rollnick, it is a method that works on facilitating and engaging intrinsic motivation to change behavior. It places the power to make modifications in the hands of the client and improves autonomy and confidence while seeking to resolve any ambivalence or indecision that may stall success. The premise of MI is that all people have a desire for self-actualization and that, through free choice and unconditional acceptance, they will seek to realize their potential. Using various types of questions—such as open ended and scaling—the coach elicits self-motivational statements and behavioral change talk with the goal of creating discrepancy, which will enhance motivation for positive change.

MI as a behavioral change method is based upon the following assumptions:

- All people possess the capacity and desire for self-actualization.
- The power to change is within the client.
- Ambivalence is a normal part of change that becomes a motivational obstacle in the process of change.
- Ambivalence can be overcome through the coach-client alliance as a collaborative partnership that incorporates the expertise of both parties.

MI is guided by five unique principles:

- 1 Express empathy to the client through reflective listening
- 2 Uncover ambivalence
- 3 Avoid argument and direct confrontation
- 4 Adjust to client resistance rather than opposing it directly
- 5 Support the client with encouragement and optimism

EXPRESS EMPATHY

Empathy is a specifiable and learnable skill for understanding another's meaning through the use of reflective listening. An empathic style does the following:

- Communicates respect for and acceptance of clients and their feelings, which may include an “I hear what you’re saying” response by the coach when a client says something. Encourages a nonjudgmental, collaborative relationship between the coach and the client, which can be fostered through the use of comments such as, “We’re a team that’s going to make good things happen for you.” Allows the coach to be a supportive and knowledgeable expert who is there to help the client. Comments such as “You’re doing great and I’d like you to try a new way of doing an exercise I think you’re going to like” may be beneficial.
- Sincerely compliments rather than tries to gain advantage by belittling the client and their efforts. Telling a client, “Look at how far you’ve come and how well you’re doing,” provides needed encouragement.
- Listens rather than tells. A statement such as, “You were saying how much you like doing those dumbbell incline flys, and, if you like them, just wait until I show you a great new exercise I’d like you to try,” lets the client know that the coach is truly listening and allows them to participate in the development of their own program.
- Gently persuades, with the understanding that the decision to change is, and always will be, the client’s prerogative. For example, a nutrition coach could gently persuade a client to accept a meal-plan modification by saying, “You were saying how much your energy has increased since we’ve added a snack to your diet. What would you think if we added one healthier snack meal later in the day?”
- Provides support throughout every part of the client’s program to change their body and life through the use of supportive commentary; commentary might include, “You are doing so well, and I’m proud of how far you’ve come. Please let me know if you have any questions about what we’re doing or anything else on your mind that I might be able to help you with.”

The client wants to feel that whenever they are with the coach, they will be in a safe, open, and nonjudgmental environment. They want to feel assured that the coach will understand their unique perspective, feelings, and values. MI is most successful when a trusting relationship is established between client and coach.

The key is to listen.

DID YOU KNOW THERE ARE

12 barriers to effective listening?

- 1 Ordering or directing. Directing someone involves assuming the role of authority or power in the relationship. The trainer may be the one a client views who is in a position of power, or the words may simply be phrased and spoken in an authoritarian manner.
- 2 Warning or threatening. Threats and warnings are similar to ordering but include an overt or covert threat of impending negative consequences if the advice or direction is not followed. The threat may be one the nutrition coach will carry out or simply a prediction of a negative outcome if the client doesn't comply—for example, "If you don't listen to me and do what I'm telling you, you'll be sorry."
- 3 Giving advice, making suggestions, or providing solutions prematurely or when unsolicited. The message recommends a course of action based on the nutrition coach's knowledge and personal experience. These recommendations often begin with phrases such as, "What I would do is..."
- 4 Persuading with logic, arguing, or lecturing. Persuading, and especially lecturing, implies that the client is either not capable or has not reasoned through the problem adequately and needs help to do so.
- 5 Moralizing, preaching, or telling clients their duty. Moral statements, like ordering, assume a position of authority or dominance and often contain such words as "should" or "ought" to convey moral instructions.
- 6 Judging, criticizing, disagreeing, or blaming. Blaming and criticizing almost always shut down communication as they imply that something is wrong with the client or with what the client has said. Even simple disagreement may be interpreted as criticizing.

12 barriers to effective listening? (Continued)

- 7 Agreeing, approving, or praising. When whatever the client has said is agreed with, the underlying message is that what the client does has no relevance—as everything is always approved. Unsolicited approval can also interrupt the communication process (sometimes clients feel that they are not listened to) and can imply an uneven relationship between the nutrition coach speaking and the client who is listening. Reflective listening does not require agreement.
- 8 Shaming, ridiculing, labeling, or name-calling. Shaming and ridiculing are forms of contempt and express overt disapproval and intent to correct a specific behavior or attitude. There is perhaps no greater barrier to communication and listening than shaming.
- 9 Interpreting or analyzing. Nutrition coaches can be frequently and easily tempted to impose their own interpretations on a client's statement and to find some hidden, analytical meaning. Interpretive statements might imply that the nutrition coach knows more about the client's real problem than the client does.
- 10 Reassuring, sympathizing, or consoling. Nutrition coaches often want to make the client feel better by offering consolation. Such reassurance can interrupt the flow of communication and interfere with careful listening.
- 11 Questioning or probing. Nutrition coaches often mistake questioning for good listening. Although the nutrition coach may ask questions to learn more about the client, the underlying message is that the nutrition coach might find the right answer to all the client's problems if enough questions are asked. In fact, intensive questioning can interfere with the spontaneous flow of communication and divert it in directions of interest to the nutrition coach rather than the client.
- 12 Withdrawing, distracting, humoring, or changing the subject. Although humor may represent an attempt to take the client's mind off the barriers and obstacles to that client making changes in their life, it also can be a distraction that diverts communication and implies that the client's statements are unimportant.

UNCOVER AMBIVALENCE

In uncovering ambivalence, the goal is to create a discrepancy between what a person is currently doing (their current lifestyle choices that include diet and exercise) and where they would like to be (losing weight, exercising more, looking and feeling better). Often uncovering this discrepancy is a huge revelation for clients. Becoming aware of their own internal resistance to change may make a client more receptive to the support and tools needed to achieve their goals.

Listening carefully to clients when they talk about what is important to them will help a coach gain perspective and get a sense of the meaningful pain points important to a client presently and in the past. Equally as important, the coach will get a sense of what is holding the client back from progression.

Ambivalence is the difference between the client who stands in front of a coach in the gym ready to make healthy changes in their life and the client who later goes home, feels overwhelmed, doubts themselves, and acts on impulses that are not aligned with their goals. For change to be long lasting, a coach must go through the client's ambivalence and uncovering the source through careful listening and reflective statements, which not only develops a powerful alliance but motivates their own desire for change.

AVOID ARGUMENT

Clients who are hostile, defiant, or provocative can be frustrating; however, a fundamental principle of MI is to avoid argument. Trying to convince a client that a problem exists or that change is needed can bring on even more resistance. Trying to prove a point to the client can lead to arguments, which can then rapidly deteriorate into power struggles that do not enhance motivation for beneficial change. A cornerstone goal of MI is to have the client voice arguments for change instead of the professional telling them.

AVOID RESISTANCE

Client resistance is a normal reaction, and each client will have challenges that will require time and energy to overcome. Clients can show resistance by behaving defiantly, or conversely, by showing a lack of effort toward the changes they have declared they wish to make.

Resistance, however, is also a signal for the nutrition coach to change direction or listen more carefully. Hidden in every struggle is an opportunity to respond in a new and possibly more effective way. Adjusting to resistance is like avoiding an argument in that it invites a coach

to express empathy by remaining nonjudgmental and respectful and encouraging the client to communicate and stay involved in the program.

Here are seven strategies to help a nutrition coach deal with client resistance:

1 **Simple Reflection**

The simplest approach to responding to resistance is with nonresistance, by repeating the client's statement in a neutral form. This acknowledges and validates what the client has said and can elicit an opposite response.

Client: *I don't plan to change what I'm doing anytime soon.*

Nutrition coach: *You don't think that exercising and eating better would work for you right now.*

2 **Amplified Reflection**

Another strategy is to reflect the client's statement in an exaggerated form—to state it in a more extreme way but without sarcasm. This can move the client toward positive change rather than resistance.

Client: *I don't know why my family is worried about my weight and how I look. I don't look much different than most of my friends.*

Nutrition coach: *So what you're saying is that you think people around you are worrying needlessly.*

3 **Double-Sided Reflection**

A coach can acknowledge what the client has said but then restate contrary statements the client has said in the past. This requires the recall of information that the client has offered previously, although perhaps not in the same session.

Client: *I know you want me to give up junk food completely, but I'm not going to do that!*

Nutrition coach: *I remember your saying before that you know that too much junk food can keep you away from the changes you'd like to make, but it sounds like you're not at that point to think about stop eating junk food altogether.*

4 **Shifting Focus**

A coach can defuse a client's resistance by helping them shift focus away from obstacles and barriers. This method offers an opportunity to affirm the client's personal choices regarding the conduct of their own lives.

Client: *I can't stop eating junk or fried or fatty food when all my friends are doing it.*

Nutrition coach: *You're way ahead of me. Let's continue speaking about whether you can (insert different topic here like get a new job, meet someone to be in a relationship, meet new friends). We're not ready yet to decide how your eating habits fit into your goals.*

5 Agreement with a Twist

A subtle strategy is to agree with the client but with a slight twist or change of direction that propels the discussion forward.

Client: *Why are you and my friends so stuck on my being overweight? What about all their problems? You'd be unmotivated and eat like I do, too, if your friends and family were nagging you all the time.*

Nutrition coach: *You've got a good point there, and that's important. There is a bigger picture here, and maybe I haven't been paying enough attention to that. It's not as simple as one person's eating or exercising. I agree with you that we shouldn't be trying to place blame here.*

6 Reframing

A good strategy to use when a client denies personal problems is reframing—offering a new and positive interpretation of negative information provided by the client.

Client: *My husband is always nagging me about my eating and exercising and is always calling me lazy and fat. It really bugs me.*

Nutrition coach: *It sounds like he really cares about you and is concerned, although he expresses it in a way that makes you angry. Maybe we can help him learn how to tell you he loves you and wants the best for you in a more positive and acceptable way.*

7 Siding with the Negative

One final strategy for adapting to client resistance is to side with the negative and play devil's advocate.

Typically, siding with the negative is stating what the client has already said while arguing against change, perhaps as an amplified reflection. If a client is ambivalent, a coach taking the negative side of the argument evokes a “Yes, but...” from the client, who then expresses the other (positive) side. The coach should be cautious, however, in using this too early in talks with the client.

Client: *Well, I know some people think I eat too much, but I still don't believe I'm too fat.*

Nutrition coach: *We've spent some time now going over your positive feelings and concerns about your eating, but you still don't think you are ready or want to change your eating patterns. Maybe changing would be too difficult for you, especially if you really want to look and feel the same as you do now? Could you change if you really wanted to?*

SUPPORT CLIENTS WITH OPTIMISM AND ENTHUSIASM

Many clients do not believe they have the power to make lasting changes in their lives. However, the reality is that everyone possesses the capacity for change. By giving a client hope, optimism, and encouragement that they can change and that the coach will be there to help them every step of the way, the coach can help a client see that they have the power within them to make the changes they want and to reach their goals. Confidence is key for self-efficacy and can also drive motivation.

MOTIVATIONAL INTERVIEWING STRATEGIES

STRATEGY #1: ASK OPEN-ENDED QUESTIONS

Asking open-ended questions helps the coach understand a client's point of view and elicits their feelings about what's important to them. Here are some examples:

- How has your body changed since we started working together?
- Which of the nutritional changes we've made do you like best and why?
- Besides having more energy, strength, and tone, what other things have you noticed that eating better and exercising more have made you feel?

Open-ended questions encourage dialog; they cannot be answered with a single word or phrase and do not require any particular response. They are a means to solicit additional information in a neutral way. Open-ended questions encourage clients to do most of the talking, help the coach avoid making premature judgments, and keep communication moving forward.

STRATEGY #2: LISTEN REFLECTIVELY

Reflective listening requires accurately listening and understanding a client's communication by restating its meaning.

That is, the coach should restate what the client intended to convey and express it in a responsive statement, not a question. Reflective listening is a way for the coach to check rather than assume that they knew what was meant. It strengthens the empathic relationship between the nutrition coach and client. Here are some examples:

Nutrition coach: *What else concerns you about your exercise and eating habits?*

Client: *Well, I'm not sure I'm concerned about it, but I do wonder sometimes if I'm not doing enough or eating too much.*

Nutrition coach: *Too much of...?*

Client: *Too much junk food for my own good, I guess. Sometimes when I wake up in the morning, I feel awful, and I feel awful for the rest of the day.*

Nutrition coach: *It makes you feel ill all day?*

Client: *Yes, and it makes me tired and lethargic.*

Nutrition coach: *And you think it might be because you're eating too much?*

Client: *Well, I know it is sometimes.*

Nutrition coach: *You're pretty sure about that. But maybe there's more...Client: Yeah, even when I'm not eating so much, my body aches, and I have such a lack of energy, and I wonder...*

Nutrition coach: *Wonder if...?*

Client: *If not getting enough exercise or eating the wrong kinds of foods is affecting my body, I guess.*

Nutrition coach: *Do you think that could happen to you?*

Client: *Well, can't it? I've heard about other people having health issues later in life.*

Nutrition coach: *Yes. I can see why you might be thinking about that.*

Client: *But I don't think I've reached that point yet.*

Nutrition coach: *You don't think you're that bad off, but you do wonder if maybe you're overdoing it with the food and not doing enough with the exercise and not helping yourself in the process.*

Client: *Yes.*

Nutrition coach: *Tell me, what else are you thinking about?*

STRATEGY #3: SUMMARIZE

Nutrition coaches will find it useful to periodically summarize what has occurred in a current or past one-on-one session with the client. Summarizing consists of repeating the essence of what a client has expressed and communicating it back to them aloud. This practice reinforces what has been said, reaffirms that the coach has been listening carefully, and prepares the client to move on.

Summarizing is also a good way to begin and end each training session and to provide a natural bridge when the client is transitioning between stages of change. When presenting a summary, the coach can select what information should be included and what can be minimized or left out. Input by the client should be invited and often leads to further comments and discussion.

STRATEGY #4: AFFIRM AND VALIDATE

When it is done sincerely, affirmations and validation of a client's words and experiences help build trust with the client. By affirming, the coach is saying, "I hear you, and I understand you."

Affirming also helps clients feel confident about tapping into their autonomy and confidence to act and change their behavior. Emphasizing past experiences will help clients remember their strengths, successes, and ability to progress and can help prevent discouragement or relapse.

STRATEGY #5: UNCOVERING AND ADDRESSING AMBIVALENCE

Scaling questions draw attention to the thoughts, feelings, and actions that influence a client's behavior by asking them to quantify the extent to which they desire change. Additionally, this type of questioning can help to increase awareness of a client's current level of motivation to change.

SCALING QUESTIONS:

Simple questions that ask for a response on a sliding scale—for example, 1 to 10.

Examples include the following:

- On a scale of 1–10, how much do you want to become healthier?
- On a scale of 1–10, how much do you want to lose weight?

A coach can identify ambivalence or obstacles that currently exist with questions such as these:

- On a scale of 1–10, rate how much you feel you may not be able to reach your health goals.
- On a scale of 1–10, rate the likelihood that you will not change your behavior.

If discrepancies in motivation and ambivalence exist, a coach can point them out and begin to address them with a client. Questions that ask what small steps a client can take to reduce the effect of their ambivalence will orient them toward solutions to initiate the process of change. Instead of focusing on what is holding them back or ways in which change has not been accomplished, these questions focus on what resources a client must begin using to activate natural desire for change.

Finally, the coach should let the client voice what the next steps will be. When they can state their path, it is more likely to be followed. This also allows clients to take ownership of their process.



CLIENT ASSESSMENT AND GOAL SETTING

LEARNING OBJECTIVES

- 1 | Understand client assessments used by a nutrition coach.
- 2 | Employ the appropriate assessment forms with clients.
- 3 | Discuss the importance of setting goals with clients.
- 4 | Describe SMART goals.

There are many reasons why clients seek the guidance of a nutrition coach. Each client has a unique set of goals they wish to accomplish, ranging from better health to improving the way they feel. A nutrition coach is obligated to assess a client before organizing a program for them. This allows the coach to determine underlying motivations, establish realistic goals, and make a plan for progress.

ASSESSMENTS

ASSESSMENTS:

The evaluation or estimation of the nature, quality, or ability of an individual.

When building rapport with a client, a nutrition coach can perform a variety of **assessments** to gather information and establish a baseline. Here are several useful types of assessment:

- **Personal:** a client's demographic information (where they live and contact information) and answers to general questions about their initial goals and how they heard about the nutrition professional.
- **Physical:** data such as weight, height, age, measurements, and bodyfat percentage if possible.
- **Health:** current and past health history via a health questionnaire.
- **Physical activity:** information about the level of physical activity the client is currently doing and how often.
- **Photographic:** photos of the client to better track progress.
- **Behavioral:** food diaries tracking a minimum of three days to get a big picture of the client's eating and snacking behaviors.
- **Psychological:** the stages of change and levels of motivation a client has as they begin and progress through their process.

PERSONAL ASSESSMENTS

Personal assessments begin the process of data collection, starting with basic information such as a client's address, contact information, emergency contact, and their initial goals. A client can fill out a form for these questions, or a coach can sit and speak with the client to gather the information. An in-person assessment of this kind is more effective since it is more like a conversation with the professional taking notes. Rapport grows as a client and coach discuss these personal details.

PERSONAL ASSESSMENTS:

The collection of demographic and initial data from a client.



PHYSICAL ASSESSMENT

Physical assessments are vital with any type of health and fitness coaching as they provide a picture of the current state of the client. These assessments collect **objective data**, including the following:

- Weight
- Height
- Body composition
- Circumference measurements
- Skinfold measurements (if possible)

PHYSICAL ASSESSMENTS:

Objective data about the client's physical status.

OBJECTIVE DATA:

Data collected through observations and actual data, not opinions.



Each of these pieces of data can be collected whether coaching is performed in person or virtually, except potentially skinfold measurements. A coach may have to collect this information in person for accuracy, assuming most clients will not have the tool needed to gather skinfold measurements. All physical measurements can be tracked and, except for height, will change over time.

If a coach is unable to obtain a body composition device such as a handheld or InBody scale, they can use a client’s circumference measurements, weight, and height to enter into one of many online composition calculators. Websites such as HealthStatus.com and ACTIVE.com have free calculators accessible online.

Table 12.1 The Pros and Cons of Physical Assessments.

PHYSICAL ASSESSMENT	PROS	CONS
Weight	Easy measurement to collect	Changes in weight do not explain what is changing
Height	Most clients will know their height; it is helpful in body composition calculation	None
Body composition	Gives detail on body mass and fat mass	May be difficult to calculate if proper tools are not available
Circumference measurement	Helpful for body composition calculation, easy to track changes	Not all clients know how to gather this data, consistency of measurement locations
Skinfold measurements	Helpful for body composition calculation	Most clients won’t have the tool, consistency of measurement locations

HEALTH ASSESSMENTS

Health assessments use health history questionnaires to gather client information regarding current and past health history. Questions outside of a nutrition coach's scope of practice include probing into health conditions or treatment plans, but asking for general details on health status is important. A coach must have a full understanding of health status and potential limitations to the services they offer. This is also an ideal time to collect medical professional documentation the client wishes to provide. This information may provide a doctor's clearance for participation in nutrition services, limitations suggested by a medical professional that a coach should be aware of, and current health care provider information should the coach need to reach out for questions or clarifications.

For health questionnaires, the following questions can be helpful:

- Are there any specific dietary needs?
- Are there any conditions that are complicated by dietary intake?
- Are there any food allergies or restrictions?
- Have blood sugar related problems such as hypoglycemia or diabetes been observed?
- Have any metabolic problems such as hypothyroidism been observed?
- Is there a family history of disease or addiction?

The **PARQ+** and health history or screening questionnaire that personal trainers use is a good option for a nutrition coach to gather appropriate health data to keep on file.

PHYSICAL ACTIVITY ASSESSMENTS

A client's current level of physical activity is important for a nutrition coach to properly assess their calorie needs and expenditures. An exercise history questionnaire provides information on current sports, frequency of activity, and level of fitness.



HEALTH ASSESSMENTS:

Questionnaires used to collect current and past health history from a client.

PARQ+:

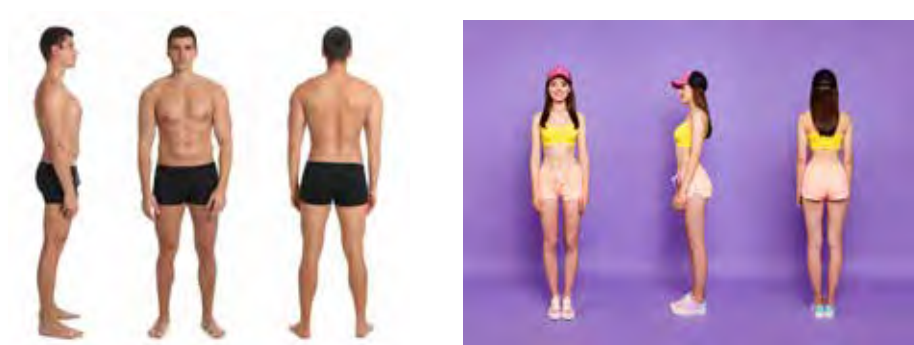
The Physical Activity Readiness Questionnaire used by physical trainers to gather client health information.

PHOTO ASSESSMENTS

Photos are a great way for clients to see their progress throughout a nutrition coaching program. It is also important for virtual coaching as a way for the coach to see changes along with the objective data collected for physical assessments. Photos can also boost motivation and celebrate achievements and milestones along the way.

Photos should be collected in an appropriate manner. Clothing should be worn for all images shared, and a coach may request tighter-fitting garments to show the physical form. Front, back, and side angle shots are typically most appropriate.

Figure 12.1 Client Photos.



BEHAVIORAL ASSESSMENT

Within the scope of practice for a nutrition coach, behavioral assessments can be made. The applicable assessments include nutrition behaviors and a nutrition diary. For nutrition diaries, the more data a client can provide, the better. A **client dietary worksheet** collects a single day's data on what was eaten, when, and approximate quantities. A **three-day dietary record** collects nutritional data for three days with as much detail as possible. Ideally, 7–14 days of nutritional diaries will provide a coach a broad enough view to understand a client's nutritional habits and pitfalls and how they respond to stress, holidays, gatherings, and so on. A nutrition coach can take the time to go through the diary with the client to determine their mind-set each day and whether there were any significant events that influenced their eating habits.

CLIENT DIETARY WORKSHEET:

A form to collect a single day's nutrition data from a client.

THREE-DAY DIETARY RECORD:

A form to collect three days of nutrition habits from a client.



A coach can also ask questions to establish how clients respond to stressors in their lives. For many, food is an outlet for anxiety, stress, sadness, or boredom. A coach can create a questionnaire that asks the client the following questions:

- Do you eat when you are bored?
- Do you snack late at night?
- How long after waking is your first meal?
- What do you do when you are stressed?
- Does eating give you comfort? If yes, how so?
- Do you feel a loss of control around food?
- Do you eat at unusual times?
- Do you eat until you feel full or until you feel stuffed?
- Does food make you feel uncomfortable?

The point of these questions is not to diagnose disordered eating or dig into the client's psychological status with food. It is simply to understand how they use food to cope with daily life, if at all. A nutrition coach should not probe into these questions but use their referral network if they feel someone requires additional assistance with their relationship with food.

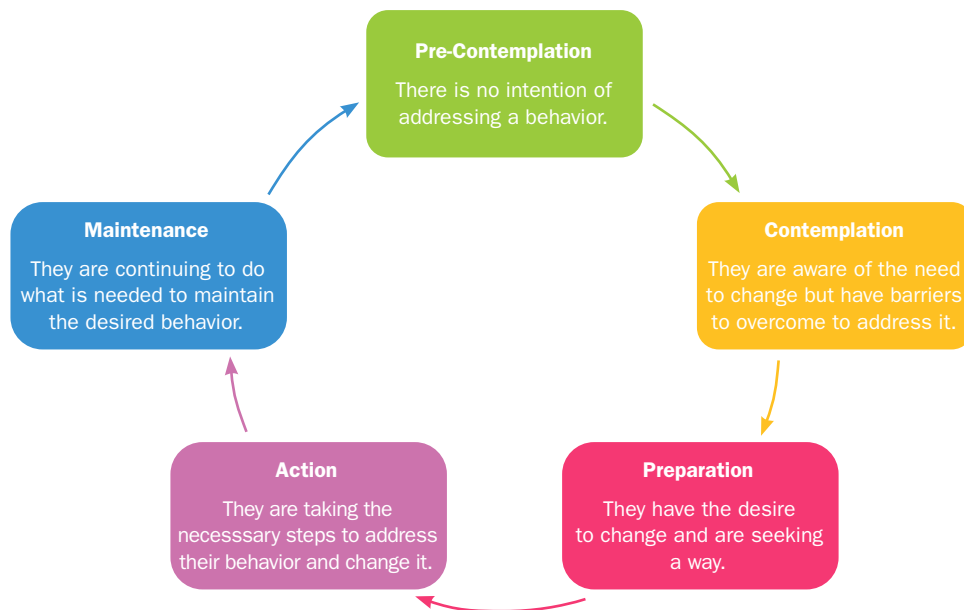
PSYCHOLOGICAL ASSESSMENTS:

Questions regarding what motivates the client, what they feel distracts them from their progress, and how they feel about their nutrition journey—past and present.

PSYCHOLOGICAL ASSESSMENTS

A nutrition coach is concerned with the psychology dealing with a client's motivation and readiness to change. **Psychological assessments** include questions regarding what motivates the client, what they feel distracts them from their progress, and how they feel about their nutrition journey—past and present. Details collected can allow a coach to establish the client's current stage of change and better tailor their program to keep them motivated.

Figure 12.2 The Stages of Change.



In the initial assessment of a client, the first two elements of motivational interviewing apply:

- 1 Expressing empathy to the client through reflective listening
- 2 Uncovering ambivalence

A coach will actively listen as they establish a relationship through the assessment process with a goal of uncovering realistic goals and what is motivating the lifestyle changes. As the relationship and communication continues throughout the nutrition program, the coach will have the opportunity to use the remaining three principles of motivational interviewing to further delve into a client's goals, ambivalences, and roadblocks.

REASSESSMENT

Periodically throughout the process, **reassessment** will be required to measure progress and understand plateaus. A coach can determine the frequency with which to reassess the following:

- Nutrition diaries
- Physical assessments
- Photo assessments

The periodic reassessments will identify noncompliance but also successes, progress, and changes in behavior. The positive results must be celebrated along the way and will drive and hopefully improve a client's motivation to continue and set new goals.

A nutrition coach should keep a client's assessment records, especially any details on their medical history, in a safe place. Even after the cessation of a client's program, it is recommended that a coach maintain records for up to three years. Health care providers must keep records for five to ten years after a patient's last visit, discharge, or death.

REASSESSMENT:

Repeating a previously completed assessment for comparison.

SETTING GOALS

Goal setting is the process of establishing what someone wishes to achieve and measurable timelines to do it. Without a goal, there is no effective programming. A nutrition coach uses a client's goal(s) in establishing effective steps to address and change behaviors, affect nutritional choices, and maintain or increase motivation and confidence in the process. Goals are flexible and can change often, so reassessments are key for a coach to stay in touch with client needs and desires.

GOAL SETTING:

The process of establishing what someone wishes to achieve and measurable timelines to do it.

TYPES OF GOALS

There are many types of goals but only a few that a nutrition coach would be concerned with. Goals related to education, relationships, health, physical concerns, behavior concerns, personal development, and career as well as financial, spiritual, and psychological concerns all exist in the realm of goal setting. Physical, health, and behavior goals are the most applicable since nutrition and lifestyle affect both.

Physical Goals

- Physical goals are subjective in nature and can be measured and reassessed. To be SMART goals, they must be realistic, achievable, and within the scope of a nutrition coach. Here are a few examples:
 - Losing ten pounds in six weeks
- Reducing bodyfat percentage by 2 percent in three months
- Improving leg strength by 20 percent in one month
- Bench pressing 200 pounds in six weeks of training
- Being able to do a pull-up

Health Goals

Health goals revolve around the health of the client and can include things like the following:

- No longer needing a medication for a chronic condition
- Getting seven or more hours of sleep every night
- Reducing blood pressure or resting blood sugar levels

Health goals are often a side effect of the client's overall success. For example, if a client loses 15 pounds during their program, the resulting physiological effect may be a reduction in blood pressure or blood sugar levels.

Behavior Goals

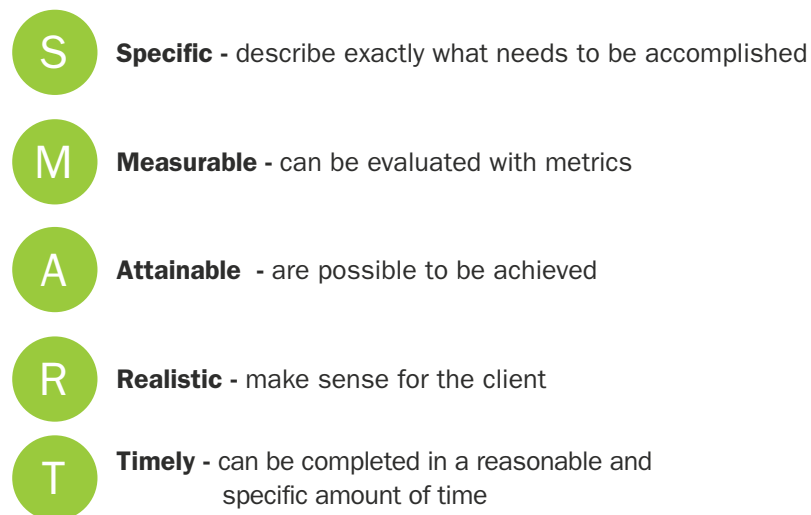
Behavior goals are those involving a specific behavior change, one the client has control over. Perhaps it is an adjustment to a current behavior or the introduction of a new one. Here are some examples:

- Drinking only one cup of coffee per day
- Consuming 15 grams of protein for breakfast every day
- Eating dessert once a week
- Exercising for 20 minutes every day

SMART GOALS

SMART goals are specific, measurable, attainable, realistic, and timely. Using the outline of a SMART goal when establishing desired program outcomes ensures a clear path to success and makes it easier for a nutrition coach to help the client progress.

Figure 12.3 SMART Goals.



Here's an example of how to create a SMART goal. The client says they want to eat healthier. The coach can help them turn this into a SMART goal by asking, "What does 'healthier' mean to you?" They respond by saying they want to eat three servings of vegetables daily. The coach replies, "When would you like to consistently do this?" The client responds, "Within the next month."

- Specific: The client eats three servings of vegetables daily.
- Measurable: The client can physically measure three servings of vegetables.
- Attainable: It is possible to eat three servings of vegetables a day.
- Realistic: The client currently eats vegetables at least every other day and has access to a grocery store to purchase them.
- Timely: They want to do this within a month—four weeks.

Having a SMART goal is just one part of the goal-setting process that will be repeated with each goal a client sets.

GOAL-SETTING STEPS

The following are seven steps in the goal-setting process, which is cyclical in nature:

- 1 Determining the desired result and willingness to do the work to achieve it
- 2 Creating a SMART goal
- 3 Writing the goal(s) down
- 4 Creating a plan of action
- 5 Establishing a timeline
- 6 Acting
- 7 Reevaluating and assessing progress

The first step is the most important. A client may have something they wish to achieve physically or behaviorally, but if they are not willing to put in the time and effort it will take, the goal may not make sense for them. If a client offers a laundry list of potential goals, a nutrition coach must help them prioritize them and narrow down the most important ones. For example, a client wants to get off their blood pressure medication, lose 35 pounds, stop eating ice cream every night, and lose 10 inches from their midsection.

Most nutrition coaches would find the goal of getting off blood pressure medication the most urgent and begin their process there. Follow-up questions about the client's goals can also help to prioritize them:

- Why is it important to be off blood pressure medication?
- Why is 35 pounds an important number?

These open-ended questions allow a client to reveal their true motivations for wanting an outcome. They may reveal that their doctor has set one or more of these goals for them or that they were a certain weight or size before and wish to achieve it again. A nutrition coach has an opportunity to use active listening and motivation to help a client understand what the process will look like. The next step of creating a SMART goal to achieve this will most likely encompass changing their nutritional choices and losing pounds and inches.

Writing goals down makes them more tangible and easily referenced during reassessments. It also allows a coach the opportunity to adjust or change goals throughout the process. A written plan of action and a timeline will also keep the client moving toward their goals. There will be setbacks, barriers, and plateaus requiring adjustments to both, but as long as the end goal is the focus, a coach can ensure forward progress.

Like client assessments, goals must be reassessed periodically. They may change or be achieved, and a new goal should replace it. Reassessment also allows a nutrition coach to look for noncompliance or issues impeding progress and make necessary adjustments to a client's program. Reevaluations are good opportunities for the coach and client to reconnect and continue to build their professional relationship.

Figure 12.4 Goal-Setting Steps.



FORMS



Client Intake Form

Please print clearly.

Name:	Date of Birth:	Age:
Address:		
City, State, Zip:		
Home Phone:	Work Phone:	
Employer:	Occupation:	

Please answer the following questions (circle one):

Has a doctor diagnosed you with a heart condition?	Yes	No
Have you ever had angina pectoris, sharp pain, or heavy pressure in your chest as a result of exercise, walking, or other physical activity such as climbing stairs? <i>(Not including the normal out of breath feeling that results from normal activity)</i>	Yes	No
Do you experience any sharp pain or extreme tightness in your chest in cold temperatures?	Yes	No
Have you ever experienced rapid heart beat or palpitations?	Yes	No
Have you ever had a real or suspected heart attack, coronary occlusion, myocardial infarction, coronary insufficiency, or thrombosis?	Yes	No
Have you ever had rheumatic fever?	Yes	No
Do you have or have you had diabetes, hypertension, or high blood pressure?	Yes	No
Does anyone in your family have diabetes, hypertension, or high blood pressure?	Yes	No
Has any blood relative (parent, sibling, first cousin) had a heart attack or coronary artery disease before the age of 60?	Yes	No
Have you ever or do you take medications or been on a special diet to lower your cholesterol?	Yes	No
Have you ever taken digitalis, quinine, or any other drug for your heart?	Yes	No
Have you ever taken nitroglycerine or any other tablets for chest pain?	Yes	No
Are you overweight?	Yes	No
Are you under excessive stress?	Yes	No
Do you drink heavily?	Yes	No
Do you smoke tobacco?	Yes	No
Do you have a physical condition, impairment or disability, including a joint or muscle problem, that should be considered before you begin a nutrition program?	Yes	No
Are you over 65 years old?	Yes	No
Are you over 35 years old?	Yes	No
Do you exercise fewer than three times per week?	Yes	No



Medical History

Name:		Date:	
Please indicate if you (personally) have a history of the following:			
1.	Heart attack	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
2.	Bypass or cardiac surgery	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
3.	Chest discomfort with exertion	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
4.	High blood pressure	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
5.	Rapid or runaway heartbeat	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
6.	Skipped heartbeat	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
7.	Rheumatic fever	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
8.	Phlebitis or embolism	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
9.	Shortness of breath w/ or wo/exercise	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
10.	Fainting or light-headedness	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
11.	Pulmonary disease or disorder	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
12.	High blood fat (lipid) level	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
13.	Stroke	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
14.	Recent hospitalization for any cause	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
Reason:			
15.	Orthopedic conditions (including arthritis)	<input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>
Please describe:			

Please list any other diagnosed conditions and when they were diagnosed below:



Health History

Print your answers. Please print clearly.

Name:	Date of Birth:	Age:
Address:		
City, State, Zip:		
Home Phone:	Work Phone:	
Employer:	Occupation:	
In case of emergency, please notify:		
Name:	Relationship:	
Address:		
City, State, Zip		
Home Phone:	Work Phone:	

Physician Information

Current Physician:	Phone:	
Are you under the care of a physician, chiropractor, or other health care professional for any reason (circle)? If yes, list reason:		Yes No
Are you taking any medications? (If yes, please list) Medication: Dosage/Frequency: Condition:		Yes No
List any and all allergies:		
Has your doctor ever diagnosed you with high blood pressure?		Yes No
Has your doctor ever diagnosed you with a bone or joint problem that has been or could be made worse by exercise?		Yes No
Are you over 65 years of age?		Yes No
Are you used to vigorous exercise?		Yes No



Questionnaire: Health History

MEDICAL INFORMATION, CONTINUED

Is there any reason not mentioned why you should not follow a regular exercise program? If yes, please explain:	Yes	No
Have you recently experienced any chest pain associated with either exercise or stress? If yes, please explain:	Yes	No

SMOKING

Please check the box that describes your current habits:

☐ Non-user or former user; Date quit: _____

☐ Cigar and/or pipe

☐ 15 or less cigarettes per day

☐ 16 to 25 cigarettes per day

☐ 26 to 35 cigarettes per day

☐ More than 35 cigarettes per day

If there is family history for any condition, please check the box to the left. On the line to the right, please designate who in the family has or had this condition.

☐ Asthma: _____

☐ Respiratory/Pulmonary Conditions: _____

☐ Diabetes: Type I: _____ Type II: _____ How Long? _____

☐ Epilepsy: Petite Mal: _____ Grand Mal: _____ Other: _____

☐ Osteoporosis: _____

LIFESTYLE AND DIETARY FACTORS

Please fill in the information below (circle one):

☐ Occupational Stress Level: Low / Medium / High

☐ Energy Level: Low / Medium / High

☐ Caffeine Yes / No

☐ Alcohol Yes / No

☐ Anemia: Yes / No

☐ Gastrointestinal Disorder: Yes / No

☐ Hypoglycemia: Yes / No

☐ Thyroid Disorder: Yes / No

☐ Pre/Postnatal: Yes / No

CARDIOVASCULAR

Please fill in the information below (circle one):

High Blood Pressure: Yes / No Hypertension: Yes / No

High Cholesterol: Yes / No

Hyperlipidemia: Yes / No

Heart Disease: Yes / No

Heart Attack: Yes / No

Stroke: Yes / No

Angina: Yes / No

Gout: Yes / No



Questionnaire: Health History

Pain History

Check if you have or have had pain in the following. If yes, please describe:

- ☐ Head/Neck: _____
- ☐ Upper Back: _____
- ☐ Shoulder/Clavicle: _____
- ☐ Arm/Elbow: _____
- ☐ Wrist/Hand: _____
- ☐ Lower Back: _____
- ☐ Hip/Pelvis: _____
- ☐ Thigh/Knee: _____
- ☐ Arthritis: _____
- ☐ Hernia: _____
- ☐ Surgeries: _____
- ☐ Other: _____

Nutrition

Are you on any specific food/diet plan? If yes,
please list and advise who prescribed it:

Yes No

Do you take dietary supplements?
If yes, please list:

Yes No

Do you notice your weight fluctuating?

Yes No

Have you experienced a recent weight gain or loss?
If yes, explain how:

Yes No

Over what amount of time?

How many beverages do you consume per day that contain caffeine? What are they?

How would you describe your current nutritional behaviors?

Other food/nutritional issues you want to include (*food allergies, mealtimes, etc.*)



Questionnaire: Health History

Work and Environment

Please check the box that best describes your work and exercise Habits.

☐ Intense occupational and recreational effort
 ☐ Moderate occupational and recreational effort
 ☐ Sedentary occupational and intense recreational effort
 ☐ Sedentary occupational and moderate recreational effort
 ☐ Sedentary occupational and light recreational effort
 ☐ Complete lack of activity

How stressful are your environments (circle one)?

Work:	Minimal	Moderate	Average	Extremely
Home:	Minimal	Moderate	Average	Extremely

Do you work more than 40 hours a week?

Yes
 No

Anything else you would like your nutrition coach to know?

PRINTED NAME:

SIGNATURE:

DATE:

SIGNATURE OF PARENT:

or GUARDIAN (for participants under the age of 18)

WITNESS:



Questionnaire: Exercise History

Are you currently involved in a regular exercise program?	Yes	No
Do you regularly walk or run 1 or more miles continuously?	Yes	No
If yes, what is the average number of miles you cover in a workout? _____		
What is your average time per mile? _____		
Do you lift weights?	Yes	No
Are you involved in an aerobic program?	Yes	No
If yes, what type(s)? _____		
Do you frequently compete in competitive sports?	Yes	No
If yes which one(s) (circle all that apply)?		
Golf	Volleyball	
Bowling	Football	
Tennis	Baseball	
Raquetball	Track	
Soccer	Other: _____	
Basketball	Average number of times per week: _____	
Are there any sports or activities you would like to participate in? If yes, why are you currently unable to do so?		

Do you have pain when participating in sport or activity? Yes No		
If yes, please describe: _____		

NOTES: _____		

NAME: _____

SIGNATURE: _____

DATE: _____

SIGNATURE OF PARENT: _____
or GUARDIAN (for participants under the age of 18)

WITNESS: _____



7227 N 16th St., Suite 262
Phoenix, AZ, 85020

3 Day Dietary Log

Page 1 of 4

Name

Date

This dietary record must be as accurate as possible. Please do not alter your eating habits or change your meals to change what is logged and please be honest. This log will aid your nutrition coach in creating the best plan of action for your current behaviors and lifestyle.

Instructions

1. Please keep this log with you at all times and log meals, snacks, anything you eat as accurately as possible.
2. If possible, please use a food scale or measuring spoons or cups. If you do not finish an entire serving that was logged, please adjust the log accordingly. Do not guess and avoid estimating when possible.
3. Please list each ingredient in a meal separately.
4. For packaged items, use labels to determine quantities.
5. Please log for three consecutive days. If there are special events or circumstances that affect your nutrition on a certain day, please note this in the margin of the log. This will provide your nutrition coach with insight. If you wish to log for more than 3 days, please do.
6. Have this log completed and ready for your next session.

Example Log

Food Item (include brand name)	Quantity (g, ml, tablespoons [Tbs], teaspoons [tsp], cups [c], etc)	Notes (include ingredients and amounts of homemade items)
<u>Breakfast</u>		
2 pieces toast	2 pcs	Orowheat
Margarine	1 tsp	Country Crock
Orange Juice	8 oz	Tropicana
<u>Lunch</u>		
Small pizza	12-inch diameter	pepperoni, mushroom, cheese
<u>Dinner</u>		
Chicken	4 oz	Tyson
Baked Potato	8 oz	
Mixed Vegetables	2 c	peas, carrots, corn- frozen



Page 2 of 4

Date

[illegible]



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3 Day Dietary Log

Page 3 of 4

Name

Date

Day 2

[illegible]



Page 4 of 4

Date

[illegible]





CHAPTER 13

BUSINESS IN NUTRITION COACHING

LEARNING OBJECTIVES

- 1 | Explore and describe the most common styles of nutrition coaching.
- 2 | Describe how to write a nutrition coaching business plan.
- 3 | List methods for building clientele.
- 4 | Explain the importance of getting client referrals.

INDEPENDENT CONTRACTORS:

People contracted to do work or provide services for a company as a nonemployee; the company is not required to provide benefits.

FREELANCE NUTRITION COACHES:

A nutrition coach who works for themselves.

Nutrition coaches can work as **independent contractors** for a fitness facility, work directly for a health or fitness company, or work for themselves with their own client base. They are also often hired to work as employees in companies and organizations. Gyms and other types of health and fitness companies employ nutrition coaches to work with clients as a part of their services offered. Other companies may have wellness or human resources programs to promote healthy lifestyles. They may hire nutrition coaches to work with their employees.

Coaches choosing to work independently will be both nutrition coaches and small business owners. **Freelance nutrition coaches** work for themselves with their own client base and must develop a business plan, market their services, and find clients. Much of this discussion applies to freelance coaches. However, skills such as social media, marketing, training styles, and the client life cycle apply to all nutrition coaches regardless of employment status.

STYLES OF NUTRITION COACHING

The first step in starting an independent nutrition coaching business is to determine the style of coaching it will offer and the target client. Many coaches cater to the general population, but many also focus on smaller specialized groups like seniors, athletes, youth, or weight loss clients.

It is also important for coaches to keep in mind the scope of practice for a certified nutrition professional. Nutrition coaches cannot offer medical advice or diagnose conditions. They can, however, work in conjunction with medical professionals when necessary.

IN-PERSON COACHING

Nutrition coaching is flexible and can take many forms. In-person coaching is an option in health clubs, private fitness facilities, or at home. This type of coaching allows for personal attention and a closer connection with clients. The coach can collect body composition data directly, demonstrate recommendations, and demand greater accountability.

The disadvantage of this method is that it requires more logistical planning, so that both coach and client can agree on times and places to meet. The cost of a one-on-one session is also generally higher for the client. Individual in-person sessions work well with new clients, especially those just beginning a fitness and health journey. These clients need more personalized attention and guidance. They may feel uncomfortable asking questions in front of others in a group setting or may struggle to learn nutrition basics in virtual sessions.

DID YOU KNOW:

For the best results when working on health goals, clients should work on fitness and nutrition together. Many personal trainers who are also certified nutrition coaches offer physical training sessions along with nutrition guidance.

Becoming a personal trainer and offering sessions to existing clients is a smart way for nutrition coaches to expand their business. A personal training certification can be used with in-person sessions as well as virtual, group, and corporate coaching. Training sessions can be included with nutrition plans or charged separately as add-on services. Including fitness is a great way to boost a business and add value to existing services.

GROUP COACHING

Solo sessions with clients provide a good foundation, but group or community nutrition services also have a place in a coaching business. The nutrition information provided for group sessions may be more general but can still be beneficial for clients. For example, a coach may instruct groups in basics of nutrition, calculating and counting calories, and making good food choices.

Group sessions do not allow much time for individual meal planning, but question and answer sessions can provide value for clients. A group session can also be a great way to meet and network with potential one-on-one clients.

Major benefits of group coaching include support and accountability. Open communication between participants should be encouraged to promote mutual support. Online communities, in alignment with the group sessions, allow participants to communicate with the coach and other clients, which is useful for increasing compliance, motivation, and engagement with the process.

VIRTUAL COACHING

Online and **virtual coaching services** are rapidly growing in popularity with coaches and clients. A nutrition coach can reach clients globally using a website, nutrition applications, and social media platforms. Virtual coaching allows for a larger client base and the ability to work with multiple people at once. Online coaching usually involves using emails as well as videos, live online interactions, and chat forums.

VIRTUAL COACHING SERVICES:

A style of coaching conducted via live web-based video conferencing, online materials, and emails to remove the obstacle of proximity; also refers to online written and prerecorded video coaching services.



A website is essential for a virtual nutrition coach. This allows clients to log in for communication and to access resources. A website may include scheduling for live consultations, client handouts, personalized plans, and a library of blogs and videos. Consultations by phone may also be useful.

Virtual coaches may also use fitness apps like MyFitnessPal, Lose It, and MyPlate (unrelated to the US Department of Agriculture's MyPlate). Clients create profiles, enter their calorie and macronutrient goals, and log their foods. Many of these apps include nutrition tips, large food databases, weight trackers, and social connections. They range from free to \$5 to download, and use of these apps is an inexpensive way to keep in contact with nutrition clients and to monitor them and keep them accountable.

CORPORATE WELLNESS COACHING

CORPORATE WELLNESS:

Employer programs that support employee well-being, health, and satisfaction by creating a culture of health and wellness.

Corporate wellness is increasingly popular with employers. As the cost of health care rises, many employers are looking for ways to reduce their health care premiums. One strategy is to promote employee health. Keeping workers healthy lowers the costs of health care and improves efficiency on the job. Corporate wellness programs offer perks like free or reduced-cost gym memberships, nutrition services, health care professional referral programs, and financial rebates or incentives.

Research has shown that companies with corporate wellness programs see real results: 8 percent more employees self-report exercise, and more than 13 percent more employees actively manage their weight and diet. When employees are healthier, companies see lower health care premiums, decreased missed days, and improved job performance.

Nutrition coaches may offer corporate wellness and nutrition services, like other types of group sessions. There are some important advantages to doing corporate wellness. The employee pool provides opportunities to take on new individual clients. Also, typically the company hiring the coach will actively promote the coach and their services.

WRITING A BUSINESS PLAN

Planning is an important stage in the process of starting a small business. It includes learning about competing businesses, the available market, and accessing funding. A **business plan** outlines the structure, marketing, and growth of a new business.

The **Small Business Administration (SBA)** is an organization available to all small business owners and anyone interested in starting a business. The SBA offers resources like consultants and business loans. Experts in business help small business owners plan, launch, manage, and grow their operations. Most major cities have a local office.

According to the SBA, there are two types of business plans. The traditional business plan is detailed, time consuming, and useful for any new business owner looking to secure funding. It should provide detailed information about growth and financial projections so that investors or banks can make decisions about funding. A lean business plan is shorter and contains less detail. It is generally used internally for planning and is not shared externally with investors.

BUSINESS PLAN:

Outlines the structure, marketing, and growth of a new business.

SMALL BUSINESS ADMINISTRATION (SBA):

A US government agency established in 1953 to promote economic growth by counseling small businesses on start-up advice, financial advice, and tips to grow an existing business.



MISSION STATEMENT:

A formal summary of the values and goals of a company or individual.

MARKET ANALYSIS:

A qualitative and quantitative assessment of a business market that examines product and service volume, buying patterns, regulations, and business competition.

TARGET MARKET:

The particular group(s) of consumers that a product or service targets.

LIMITED LIABILITY COMPANIES:

A corporate structure in the US that limits the liability of the owner; it combines aspects of corporations and sole proprietorships.

CUSTOMER LIFE CYCLE:

The steps a customer goes through when considering, buying, and using a product or service; this includes awareness, engagement, evaluation, purchase, experience, and bonding and advocacy.

TRADITIONAL BUSINESS PLAN

The traditional format is great for detail-oriented individuals looking for a comprehensive overview and plan for a new business. There are several elements of a traditional business plan:

- The executive summary includes the what and the why of the business. It should outline the basics of the financials, **mission statement**, vision, and products or services offered. It is an introduction or an abstract.
- A detailed company description and **market analysis** should be included and will explain the business's **target market** and give an in-depth look at local competitors. This should highlight the coach's experience and anything that sets them apart from the rest of the market.
- The business plan should describe the business organization type. Many small businesses with just one or two owners are **limited liability companies**. The plan should describe the ownership structure and whether there will be employees or independent contractors.
- A comprehensive description of services offered should also include an estimate of **customer life cycle**.
- Marketing is also important in a business plan. All planned strategies for marketing should be outlined here.
- A traditional business plan is generally used to get funding, so it must include financial projections and funding requests. This part can be complicated and requires some specialized knowledge. It may be a good idea to work with an accountant or the SBA to determine how to flesh out this section. The financial projections need to be based on data and be reasonable and attainable to secure funding from investors or loans from a bank.

Figure 14.1 Perfect Customer Life Cycle.



LEAN BUSINESS PLAN

A lean business plan will include most of the same information as a traditional business plan but with much less detail. This type of plan is used primarily for the owner and any other employees to organize the structure, finances, and plans for future growth.

A lean format is appropriate for smaller businesses that will be starting up quickly and offering few services. It should establish products and services offered, their values, how customers will find the business, marketing plans, and a brief study of the market and target audience.

Regardless of type, a business plan is an important step in starting a small business. It helps with planning and organization. New coaches should take advantage of resources during the planning process, including the SBA or a local chamber of commerce.

MARKETING

Marketing is essential for bringing awareness to a new business and bringing in new clients. The first component of marketing is the creation of a business name, brand, and logo. When creating a name and look for a new business it is also a great time to start building the mission statement to help clarify the brand and goals.



Target Market

Determining a target market is an important early consideration for any business, and it will evolve over time. It is best to start with products and services offered and then determine what kind of person will be interested in them.

Using online analytics (often offered with websites and social media accounts), conducting periodic customer surveys, and monitoring social media and online activity are effective ways to determine if the business is reaching the target market.

As the business evolves, new markets may emerge that make more sense to target. Starting with one demographic does not mean that a business cannot expand into other markets or change the demographic entirely. It is acceptable and often necessary to adjust marketing and coaching focus to shift with the target market.

Business Messaging

A focused business message is key for consistent marketing and branding. To create a business message, first determine the target audience. Identify the needs of this audience and how the business will address these needs and offer solutions. With a message in place, all marketing efforts should remain consistent.

An example of a focused business message is “I’m dedicated to helping you find a lifetime of balance with food and fitness for a full, sustainable, and enjoyable life.”

A consistent business message should list attributes that set the business apart from competitors. This may include relevant experiences or credentials or a specific target audience, like seniors or young athletes. Standing out from the crowd is essential in marketing and gaining new clients.

Social Media and Online Presence

Social media and a website are the hallmarks of modern marketing. They are necessary for a business to have success and growth. These are likely to be the two main pathways that lead customers to new businesses. As the owner of a small business, it can be tempting to combine existing personal sites and profiles with those of the company. Avoid doing that, and stick with separate accounts, websites, and social media profiles.

Business profiles and marketing materials must include frequent engagement through blogs, photos, teaser articles, informative posts, and **calls to action**. These keep businesses relevant and in front of potential clients.

Business social media sites must be active, with regular following and linking to potential clients and relevant businesses and influencers. Use **hashtags** and other fitness and wellness profiles to connect with the target market.

CALLS TO ACTION:

A marketing statement that demands an immediate response from the recipient—for instance, “Click here to learn more.”

HASHTAGS:

A social media tag users can create to help others find messages and posts with a specific theme or content.

Relevant and high-traffic social media platforms for nutrition coaches to consider using include the following:

- YouTube
- Pinterest
- Facebook
- LinkedIn
- Instagram
- Snapchat



Each platform offers a unique way to share credentials and services. They can also showcase results and client testimonials. These are typically free platforms that are small business friendly. Many also have paid options for accounts that provide opportunities for greater visibility, advertising, and targeting of potential clients.

Research Competitors

Researching the competition is essential for planning and marketing. This can include reviewing local nutrition coaching and fitness businesses and evaluating business profiles, advertising, social media, and online reviews. The goal is not to copy others but to observe and look for methods that are effective or ineffective.

Businesses in the area that are well known and trusted and that have large client bases are employing good practices with their marketing. Researching the competition also helps determine ways to distinguish the business from others.

DID YOU KNOW:

A SWOT (strengths, weaknesses, opportunities, and threats) analysis is useful during the planning phase of starting a new business, but it can also be used to periodically review an existing business with the goal of making improvements.

Strengths: Nutrition coaches should reflect on and list their strengths in all areas of business, including actual coaching, client interactions, organization, marketing, and other business tasks. Coaches can use client feedback as well as self-reflection here.

Weaknesses: It is important for coaches to identify their weaknesses in all the same areas of working with clients and running a small business. This can be tough to face, but no one is perfect at everything, and there is always room for improvement. Again, coaches can use self-reflection but also be open to receiving constructive criticism from clients. Being willing to see weaknesses and improve them sets the most successful business owners apart from the rest.

Opportunities: With established strengths and weaknesses in a business, a coach can then identify opportunities. This may include taking more specialized nutrition courses, attending networking sessions, or being more aggressive with email marketing. These should be opportunities not yet used or not used fully.

Threats: Finally, it helps to look at other factors to see what might threaten a business's success. Coaches should conduct an updated review of other similar businesses in the area or in the same specialty, for instance. An employee who has caused clients to drop out is also a threat to success, as are bad reviews.



BUILDING A CLIENT LIST

It is important for coaches to develop ongoing relationships with current clients while adding new clients. Selling is part of being a small business owner. Even coaches working in gyms or for other employers must use sales tactics to bring in new clients.

DETERMINING THE NEED

Every potential client has a goal or a problem to solve. A potential nutrition client may have a goal weight or need help creating a consistent, effective diet, for instance. A nutrition coach must ask open-ended questions to determine the true need—not just the superficial needs—of a client before selling them services.

A superficial need is often a quick response someone gives when asked why they are interested in working with a nutrition coach. For example, a potential new client may say that they want to get healthy and feel better in their own skin. The true problem becomes clear when they explain more about their situation. They need to lose 50 pounds or be put on additional medications and face serious health consequences. Getting a true need comes from asking questions that require more than just “yes” and “no” answers and by listening thoughtfully to the responses.

FILLING THE NEED

With the understanding of a client's needs, it is possible to offer a viable solution. The potential new client must understand how it will help them meet their goal before committing to buying services.

A client's needs can change throughout their customer life cycle, which is why it is important for a coach to maintain a good relationship, to understand their changing needs, and to keep offering relevant services.

By asking the right questions to the client who wants to lose 50 pounds in less than a year, a coach can find out important information. Maybe they struggle with accountability and consistency, or perhaps they just need guidance for meal prep. Understanding the timeline means the coach can offer a reasonable contract for long-term coaching. By going deeper with clients to identify needs, it is possible to match those needs more precisely and to gain more clients in the process.

DID YOU KNOW:

An elevator pitch is often used in sales for all types of businesses. It is a quick 15- to 30-second rundown of a product or service. It should be short and concise yet also describe exactly what a product or service offers and the benefits of it. When a coach meets potential clients, time may be limited and the interactions brief. A successful nutrition professional should have an elevator pitch prepared.

Examples include the following:

- *“I’m a former college athlete who helps youth between 8 and 18 improve and tailor their nutrition to create strong, efficient, and durable bodies and improve their sports performance as they advance to the next level.”*
- *“I am a nutrition coach with my own weight loss success who helps others looking to lose any amount of weight, avoid chronic health issues, and feel comfortable in their own bodies.”*
- *“I am a mother of two who helps other new moms take control of their bodies, regain their physical strength, and refocus their nutrition not only for themselves but for the well-being of their families.”*

ASKING QUESTIONS AND TAKING NOTES

With a prospect considering the investment, it is time for a coach to address concerns or barriers preventing the client from signing up for services. The coach should determine a client’s hesitations or worries before closing the sale. Then they can be addressed to get a final commitment.

Talking about concerns in advance will reduce the likelihood the client changes their mind later. Objections or concerns are never bad; they are just problems to be addressed and solved. In sales, objections are a chance to earn a customer’s trust and gain even more commitment to the plan or service.

Objections to pricing can be especially tricky to manage. Nutrition coaches must set costs for sessions based on value and the current market. Pricing that is well above other coaches will limit the ability to get new clients. Pricing too low makes clients happy but leaves the coach in a difficult position, unable to earn what their services are worth.

The coach should keep the focus on the value of the service and the cost of not hiring a coach. For the example client who wants to lose 50 pounds, there is tremendous value in avoiding more medications and health complications. There is value for this person in learning how to plan and prepare consistently healthy meals.

CLOSE THE SALE

A nutrition coach has a lot of work ahead in the way of uncovering a client's motivations and barriers to success. If the step of determining the need of the client was done effectively, they will have several pieces of ammunition to use when asking for a sale:

- The potential client's reason (at least superficially) for wanting change
- Some of the things they have attempted in the past
- What they feel they failed to do previously
- Their current goals
- When they have felt successful previously
- What services offered would best fit them and why

Closing does not have to be a scary process. If the right questions have been asked and answered and the professional feels confident in their services, the question should be as simple as "Which plan works best for you?" followed by "What type of card would you like to use?"

Most coaches collect payments before delivery of services. This reaffirms commitment and ensures they are compensated for their time with no risk of having to chase people down for payment later.

CLIENT REFERRALS

A referral is an important and valuable way to build clientele. When a current or past client refers services, it means they trust the coach and value the services they offer. Referrals may even come from someone who has never been a client but who had a positive interaction with a coach. All interactions are important. Even those that do not end in a sale could lead to a referral.



PROMOTERS VERSUS DETRACTORS

Nutrition coaches and small business owners encounter two main types of people:

- Promoters are those who had positive experiences with a coach and their services. They are happy with their results and will likely refer friends or family.
- Detractors are unsatisfied with the interactions or services. These individuals will usually make themselves known very quickly. It is important to directly reach out to any detractors as quickly as possible to hear their concerns; empathize with them; and, if possible, offer a solution.

Conducting periodic surveys of current, past, and potential clients can provide useful information on the effect of marketing materials and client satisfaction.

POSITIVE SHAREABLE MARKETING MATERIAL

Using positive client reviews—with their permission only—is a great way to prove the value of services. These are like referrals, but they can be used in a range of marketing materials to reach more people. Testimonials from clients and before and after photos and stories are effective in reaching new potential clients on social media and on a business website.

Marketing materials and posts using client testimonials and stories should be positive, informative, colorful, and engaging. Coaches should encourage comments, discussions, and questions for these kinds of posts and reply in a timely manner.

WHEN TO ASK FOR REFERRALS

Any time can be good to ask for a referral or testimonial. But people are most excited about a coach's services when seeing results. It is advantageous for a coach to leverage that excitement to get a quote or to ask for a referral. The client may have family or friends who admired their progress and showed an interest in coaching services.

It is best for a coach to ask for more information about the people the clients know who may be interested to create a targeted sales pitch. For instance, if a client talks about a family member struggling to lose weight and trying diet after diet, a coach might jump in and ask more about it.

The more a coach gets to know their clients when working with them, the more they can help them reach their goals. But conversations also help the coach find potential new clients. They can use the information to pull in clients' friends and family members to sign up for services.

Some coaches find success in offering rewards for referrals. It could be as simple as an entry into a monthly drawing or a free session if the referral pans out. A reward can be an effective, inexpensive, and motivating way to drive the referral process.

Quick follow-up with referrals is essential to leverage interest in the moment. People are easier to talk to and objections are easier to overcome when they are excited and highly motivated to change.



COMMON BUSINESS MISTAKES TO AVOID

Coaching clients is different from running a business. They are two different skill sets that are both necessary for a successful business. Coaches already have the health, nutrition, and interpersonal skills but often overlook the business side of their work. Some common mistakes that new business owners make are easily avoidable.

1. Failing to track client information

Whether in print or digitally, a system for keeping track of client information is essential. Coaches should include contact information, food planning forms, food logs, progress assessments, and other important information.

2. Assuming everything must be done virtually

Not all coaches or clients like doing business online and remotely. In-person coaching may be more suitable for certain individuals and has many advantages as far as building relationships and keeping clients over the long term.

3. Assuming all clients have adequate tech skills

Coaches should prepare a plan or a quick guide to teach clients how to use technology associated with coaching. Using a new app, for instance, will be much easier if a client is given some basic instructions. Technology should not be a barrier to services.

4. Failing to check in with clients

It is important for coaches to determine a schedule for checking in with clients and to be consistent. Even if a client purchases a one-time meal plan, checking in allows them to ask questions or request additional resources or sessions. Check-ins are great opportunities to sell additional services, ask for referrals, and build relationships.

5. Not asking the right questions during the customer life cycle

Coaches do not stop asking questions at the initial assessment or intake. They should continue to engage each client through the life cycle. Purposeful questions about concerns, hesitations, successes, and referrals are most important, but conversations should be kept professional and positive.

6. Not targeting a specific demographic

Nutrition is a broad subject. Choosing a specific target client or having a specialization makes it easier to create business messaging, marketing materials, and services. Focusing on one or two target markets helps to set individual coaches apart from the rest.

7. Failing to stay organized

Organization is essential to running a service-oriented business. Without a good organization strategy, it is easy to miss appointments and communications. Being organized is a courtesy to customers, who will soon get fed up with a coach who can't keep track of meetings, paperwork, or emails.

8. Failing to maintain professional boundaries

Getting to know clients and establishing relationships builds strong businesses, but it must remain professional. There is a line that should never be crossed between a professional relationship and personal relationship. Coaches should keep all communications, conversations, and interactions business appropriate.

9. Overwhelming clients with too much information

Nutrition coaches are passionate about what they do and have a lot to share with clients. It's easy to get excited about educating clients too fast and with too much information all at once. Coaches should keep the details and information about nutrition plans relevant and manageable for each client. The information should be delivered in a way that they can easily apply to their lives. If necessary, coaches can break the information up into multiple sessions to increase adherence and comprehension.

The first step in establishing a nutrition business is to create a business plan. Resources like the SBA are available for free. There are many opportunities for a nutrition coach who is working independently, for a fitness facility, or in conjunction with a corporate wellness program. Virtual coaching, email, video, applications, and in-person nutrition coaching can be used in all of these work environments.

Social media has become a fast, inexpensive, and effective way to reach potential clients and grow a business. Platforms such as LinkedIn, Instagram, YouTube, and Pinterest allow coaches to showcase themselves and their services and to reach more people.

The sales process is important to understand and to practice, even for coaches working for larger companies. It starts with asking questions and listening to client needs, problems, and concerns. Every client has a goal or a need for nutrition services. Listening to clients is essential to showing them that a coach can fill the need and help them reach their goals.

Organization and punctuality are two skills that every successful nutrition coach possesses. Keeping accurate and organized records and plans as well as being on time for all scheduled appointments will lead to business growth and referrals. Coaching is a business, and that means that successful nutrition coaches will be good at their jobs and at running a small business.





CHAPTER 14

DIETARY GUIDELINES

LEARNING OBJECTIVES

- 1 | Define and describe the Dietary Guidelines for Americans.
- 2 | Explain the United States Department of Agriculture (USDA) nutrition programs that rely on the Dietary Guidelines.
- 3 | Define the key elements of healthy eating.
- 4 | Determine the dietary suggestions to align with healthy eating patterns

US DEPARTMENT OF HEALTH AND HUMAN SERVICES (HHS):

A US federal department that oversees public health, welfare, and civil rights issues.”

US DEPARTMENT OF AGRICULTURE (USDA):

A US federal department that manages programs for food, nutrition, agriculture, natural resources, and rural development.

DIETARY GUIDELINES:

Guidelines for healthy, lifelong eating habits for Americans two years of age and older.

FOOD AND DRUG ADMINISTRATION (FDA):

A US federal department that regulates the production and distribution of food, pharmaceuticals, tobacco, and other consumer products.

The **US Department of Health and Human Services (HHS)** and **US Department of Agriculture (USDA)** create and update the **Dietary Guidelines** for Americans to promote sustainable, healthy food choices for lifelong health and good nutrition. With the aim of preventing chronic diseases such as cancer, hypertension, stroke, heart disease, and other chronic conditions, the guidelines address what to eat and what to avoid eating for optimal health.

Foods available to American consumers today include fresh, packaged, and processed products. To make the best choices, it is important for consumers to read and understand food labels. Even the simplest food packaging includes a nutrition label, list of ingredients, and often nutrition and health benefit claims. The **Food and Drug Administration (FDA)** regulates each of these elements for accuracy and effectiveness.

The current dietary guidelines are useful for making healthy food choices and crafting a well-rounded diet. Nutrition coaches and fitness professionals can use these guidelines as the basis for helping clients develop healthier dietary habits to support their goals.

Figure 14.1 Dietary Guidelines for Americans



The first half of the 122-page Dietary Guidelines contains chapters related to various nutrition topics.

The second half of the Dietary Guidelines contains the Dietary Guidelines Appendix with helpful tables of foods, nutrient sources, calorie intake, and more.

In addition to nutrition, the Dietary Guidelines also contain information about physical activity recommendations.

PURPOSE OF DIETARY GUIDELINES

Dietary Guidelines are meant to guide the development of federal food, nutrition, and health policies and programs. The primary audiences are policy makers and nutrition health professionals, rather than the public.

This publication is a critical tool used by professionals to help Americans make healthy choices in their daily lives with the goal of preventing chronic disease. The publication serves as the evidence-based foundation for nutrition education materials that the federal government creates for the public. For example, federal dietary guidance publications are required by law to be consistent with the Dietary Guidelines.

The Dietary Guidelines are also used to guide USDA and HHS food programs as well as many other programs administered by federal departments, such as:

- The USDA's National School Lunch Program and School Breakfast Program, which feed more than 30 million children each school day
- The Supplemental Nutrition Assistance Program (SNAP)
- The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)
- The HHS Administration on Aging's Older Americans Act Nutrition Services programs, including thousands of community-based service providers
- Department of Defense and Department of Veterans Affairs food programs



The Dietary Guidelines are also used to develop programs, policies, and communication by audiences other than those specifically targeted by the document. These companies and organizations share the common goal of serving the public. They include businesses, schools, community groups, media, the food industry, and state and local governments.

The 2015–2020 Dietary Guidelines translate science into succinct, food-based guidance to help Americans choose foods for a healthy and enjoyable diet. The focus is disease prevention, not treating disease.

All Americans, regardless of individual health status, can benefit from making better food choices and developing healthy eating patterns. Thus, the Dietary Guidelines may be used or adopted by medical and nutrition professionals to encourage healthier habits in their clients.

FIVE FOCUS AREAS OF THE DIETARY GUIDELINES

The Dietary Guidelines are organized progressively, starting with five core concepts which are followed up with more detailed guidelines for food choices.

EATING PATTERN:
The types of food and beverages an individual consumes.

NUTRIENT DENSITY:
The amount of nutrients in a food relative to the number of calories it provides, usually measured per 100 kilocalories.

1. Follow a healthy eating pattern across the life span.

All food and beverage choices matter. Choose a healthy **eating pattern** at an appropriate calorie level to help achieve and maintain a healthy body weight, support nutrient adequacy, and reduce the risk of chronic disease.

2. Focus on variety, **nutrient density**, and food amounts.

To meet nutrient needs within calorie limits, choose a variety of nutrient-dense foods across and within all food groups in recommended amounts.

3. Limit calories from added sugars and saturated fats and reduce sodium intake.

A healthy eating pattern should be low in added sugars, saturated fats, and sodium.

DID YOU KNOW:

Sodium is a major target for physicians and the FDA to prevent and reduce chronic disease and hypertension. More than half of the sodium the average American consumes comes from:

- | | |
|----------------------|--------------------------------------|
| • Bread | • Snack foods, like chips, crackers, |
| • Pizza | and popcorn |
| • Canned soups | • Cheese |
| • Burritos and tacos | • Cold cuts and deli meats |

4. Shift to healthier food and beverage choices.

Choose nutrient-dense foods and beverages across and within all food groups in place of less healthy choices. Consider cultural and personal preferences to make these shifts easier to accomplish and maintain.

5. Support healthy eating patterns for all.

Everyone has a role in helping to create and support healthy eating patterns in multiple settings nationwide, from home to school, at work, and in communities.

DID YOU KNOW:

There are a variety of socioeconomic factors that contribute to an individual's food and eating habits. Economic status, belief systems, food access, culture, and many other outside influences play a role in a person's choices. Health professionals must be aware of those influences when developing plans for clients.

The Dietary Guidelines' key recommendations for healthy eating patterns should be applied in their entirety. There are complex, interconnected relationships between dietary components that can be missed if only a few recommendations are followed.

LIMITING ADDED SUGARS

It is equally important to consider what to limit in a diet for a healthy eating pattern. These include added sugars, certain fats, and sodium. These are of concern for public health in the United States. Specified limits can help individuals achieve healthy eating patterns within calorie limits.

The recommendation for **added sugars**, those sugars not found naturally in whole foods, is to limit consumption to less than 10 percent of daily calories. This is based on modeling of food patterns and national data on calorie intake. Once all the recommended food groups are consumed for a typical individual, there is no room for added sugars.

ADDED SUGARS:

Any type of sugar that is added to a food or beverage when it is processed. This is compared to natural sugars found in whole foods, like fruit or milk.

LIMITING UNHEALTHY FATS

Calories from saturated and trans fats should be limited to less than 10 percent of calories per day. This recommendation is based on research that shows replacing saturated fats with unsaturated fats is associated with reduced risk of cardiovascular disease. As with added sugars, once food recommendations are met within a day, there is little room for extra calories from saturated fats.

LIMITING SODIUM

Sodium intake is recommended in quantities less than 2,300 milligrams per day. This is the Tolerable Upper Intake Level set by the National Academy of Medicine for people ages 14 and older. Refer to the Dietary Guidelines for Americans to view the recommendation for younger children.

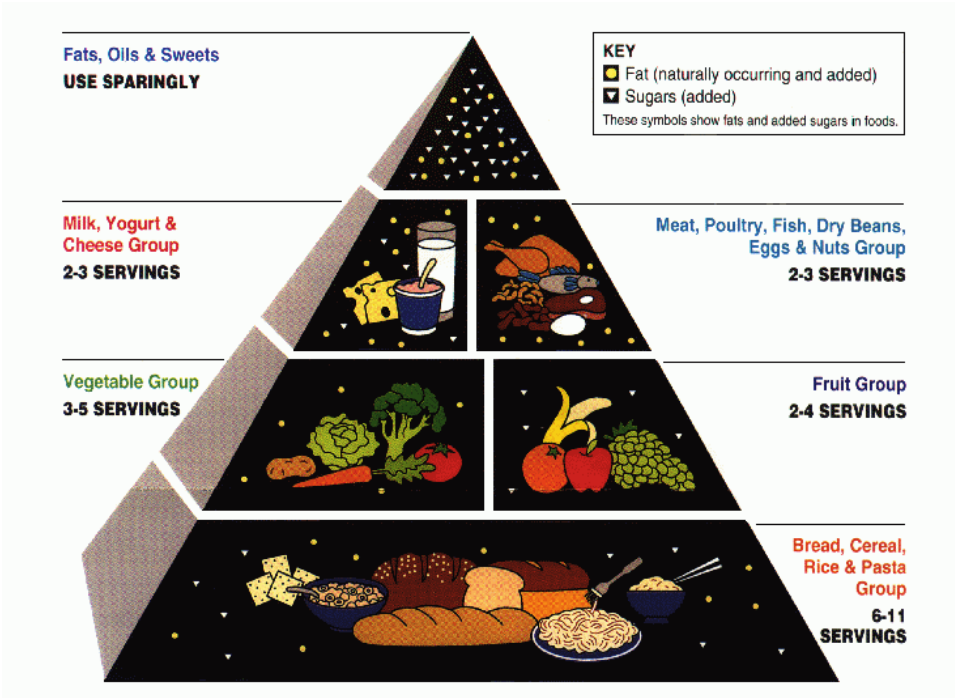
LIMITING ALCOHOL

The current recommendation for alcohol consumption is to limit beverages to one drink per day for women and two per day for men, which is considered moderate drinking. Consuming more than the recommendation is considered heavy drinking and carries health risks. See the Dietary Guidelines for Americans for more information about who should abstain completely.

THE FOOD PYRAMID TO MYPLATE

A previous representation for the Dietary Guidelines, and one that most consumers still recognize, is the Food Pyramid. It acted as a visual tool to help individuals make better choices about food and creating a healthy eating pattern.

Figure 14.2 The Food Pyramid



The Food Pyramid used the number of servings per day of each food type to represent how much the average American should consume. It included servings for grains, vegetables, fruits, meats and other protein sources, dairy, and fats. The gradual thinning of the categories up the pyramid was intended to show that grains should be the focus of the diet, with each subsequent food group making up a smaller and smaller portion. Left out however, was a distinction between healthier whole grains and the processed, sugary foods like white pasta and cereals that are now known to have contributed to the US obesity epidemic.

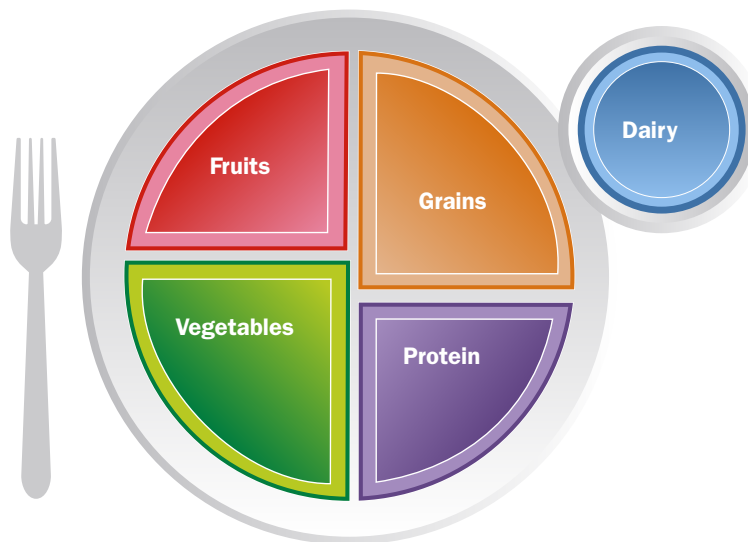
Newer resources take fats, oils, and sweets completely out of the picture. Processed foods, desserts, and sugary beverages are now treated as foods to avoid as much as possible. The food pyramid is also now thought to have put too little focus on fruits and vegetables and protein sources. The research that led to the transition from the Food Pyramid to **MyPlate** puts a greater focus on the Dietary Guidelines and choosing larger quantities of healthy whole foods.

While the Food Pyramid was a popular resource, it is now considered dated. It has been replaced with the simplified, updated MyPlate representation. The official reason for the change is to simplify the visual tool and to promote healthy eating for a new generation of Americans. The guidelines presented are the same as those from the Dietary Guidelines, but the MyPlate tools and graphics are intended for use by the general population. They provide resources that nutrition, health, and fitness professionals can use to communicate effectively with clients.

MYPLATE:

The current visual nutrition guide published by the USDA Center for Nutrition Policy and Promotion.

Figure 14.3 MyPlate



The new MyPlate is shaped like a plate with colorful fractions dedicated to dairy, vegetables, fruits, protein, and grains. This helps people visualize filling their plates at each meal with appropriate amounts of each food type. It is easy enough for a child to understand. Fats and sugars previously at the top of the Food Pyramid are left off the MyPlate graphic because of how they contribute to obesity in the overall population. Nutrition coaches and fitness professionals can use the MyPlate graphic as a teaching tool to explain healthy food choices and proportions to their clients.

DID YOU KNOW:

The USDA's first dietary guidelines were published in 1980 and have been updated every five years since 1985.

FRUITS AND VEGGIES

According to the USDA, half of a healthy plate should be fruits and vegetables. The focus should be on choosing whole fruits and vegetables which may include fresh, frozen, dried, or canned products with no additives. One can enjoy fruits as a sweet snack or dessert or with meals to increase daily intake. Vegetables should be varied in type and color. There are several healthful ways to prepare vegetables: sautéed, roasted, raw, or steamed.

GRAINS

Whole grains should fill up a quarter of a well-rounded plate. At least half the grains consumed daily should be whole grains. Any processed product is considered whole grain if the first or second item on the ingredients list is whole grains. Whole grain foods include brown rice, oatmeal, popcorn, whole wheat pasta, and whole grain breads.

PROTEINS

Lean proteins make up the final quarter of MyPlate. Seafood, beans, unsalted nuts and seeds, eggs, poultry, and lean meats are great choices for protein. Choose a variety of protein sources for building muscle tissue; for bone, blood, and skin health; and to produce hormones. Consuming protein from several different sources provides a variety of amino acids for the body to use.

DAIRY

For dairy products MyPlate encourages a switch to low-fat or fat-free products to reduce saturated fat intake. Foods like sour cream, heavy cream, and regular cheese can be replaced with lower-fat varieties.

Simple changes like choosing vegetable oils instead of butter and choosing water over sugary drinks can have a big effect over time. Nutrition coaches and trainers can encourage change by focusing their clients on small steps. A client should choose one thing to change at a time, like adding a fruit to every meal for a week or increasing the serving of vegetables in each meal. Habits generally take two to four weeks to form, and consistency is key. When it comes to eating, overhaul diets are impossible to maintain. The guidelines are a great way to inform and promote small, sustainable lifestyle changes.

MYPLATE TOOLS AND RESOURCES

MyPlate provides a variety of visual tools for trainers and coaches working with clients on nutrition. There are printable materials that can be filtered by age group and topic, videos, food safety tips, and even resources to help clients be more mindful with their food waste.

One valuable resource offered by MyPlate is the MyWins tools. These tools show consumers how to make small changes to create big results. For example, MyWins helps with healthier drink choices: instead of a 12-ounce grape soda (150 calories and 32 grams of added sugars), choose 6 ounces of 100 percent grape juice mixed with 6 ounces of club soda (115 calories and no added sugars).

Figure 14.4 MyWins Tools and Tips



Another example of a small win promoted by the MyWins tools is a food swap at lunch. Exchange a peanut butter and jelly sandwich with potato chips for a sandwich with whole wheat bread, natural peanut butter, and banana with a serving of baby carrots. This small change reduces calories, saturated fats, sodium, and added sugars.



PRODUCT AND SUPPLEMENT LABELS AND CLAIMS

LEARNING OBJECTIVES

- 1 | Identify terms related to food and supplement labeling and packaging.
- 2 | Understand key terms related to food and dietary supplement claims.
- 3 | List most claims made on food and supplement packaging.
- 4 | Describe the types of food and supplement claims regulated in the United States.
- 5 | Understand organic agriculture in the United States.

The term “wholesome” has become a popular way to describe foods that are supposed to be fresh, healthy, and packed with nutrients. However, many marketing companies use a variety of different terminology to loosely describe many products they are selling to make them seem healthier.

The ideal foods to consume are unprocessed fruits and vegetables, whole grains and cereals, lean meats, and whole and fresh foods. However, no matter how healthy, the quantity of food consumed is an important component of a healthy diet. A common misconception is that one could eat as much healthy food as they want, with little regard for calories or nutrient density. Eating too much of anything can be unhealthy and eventually slow the body down. In addition, many health foods are high in fillers, which can be anything from extra fat, sugar, salt, and other chemicals and compounds, in order to make them more palatable. Navigating and understanding what is healthy and what is not is one of the many challenges nutrition clients will face when trying to improve their diet and change their behaviors. For nutrition coaches, being able to teach people to understand labels and claims made on the food and supplements they consume is one of the keys to success.

ALL FOODS ARE NOT EQUAL

The nutrient content of whole foods varies greatly and can differ from geographic location to location and even within the same location from year to year based on the quality of the local soil. This inconsistency has been one major flaw in the nutrition approaches taken at the institutional level, which assume a potato from Idaho has the exact same nutrient content as a potato grown in Maine. In the past, dealing with this unknown nutrient content variable was difficult, but with the help of modern food technology, meeting general nutrient demands is now more effectively accomplished. The use of advanced food preparations makes getting balanced nutrition more reliable and cost effective.

THE RISE OF DIETARY SUPPLEMENTS

The first use of nutrients as supplements likely originated in medical applications. Doctors and clinical nutritionists have long employed nutrient solutions to supplement patients back to health. These products mainly consisted of intravenous solutions that delivered a liquid nutrient mix directly into the bloodstream. Today, doctors prescribe supplements to many patients of all ages and conditions for a plethora of health reasons. The use of nutrients to accelerate healing is also practiced in hospitals as a result of continuing research demonstrating the faster recovery of patients post-surgery.

Dietary supplements, also referred to as supplements, food supplements, and nutrition supplements, have exploded in popularity and use in recent years. Supplements represent major scientific advancements in nutrition and cellular processes in both general and sports nutrition. The **Food and Drug Administration (FDA)** regulates dietary supplement products and their ingredients to ensure they are properly labeled and branded. However, the companies that make the product are solely responsible for ensuring safety evaluations, labeling, and purity standards before marketing.

When people think of supplements, they tend to relate them more to drugs than to food. This is partly due to the way they are packaged and consumed (tablets, powders, capsules, etc.) and their clinical origins. It may also be attributed to the scientific research done on dietary supplements when used to treat medical conditions. In many cases, improvement in conditions like heart disease and high blood pressure were observed with the use of dietary supplements. Glucosamine, for example, is used within the United States as a supplement claimed to support connective tissues and joint health. Additional clinical research among people with osteoarthritis by Health Canada supported disease treatment claims for glucosamine as a natural health product for relieving pain associated with osteoarthritis, along with the general maintenance of good joint health.

FOOD VERSUS SUPPLEMENTS

Those who encourage the use of supplements as a part of a balanced diet can provide support for powders and pills over food sources. Nutrients from food can be hard to ingest depending on the source and availability to different demographics. Unless a client is consuming 10–20 pounds of fresh fruits and vegetables daily, it is highly unlikely they are receiving the ideal amounts of nutrition their body requires. Supplements can deliver specific amounts of desired vitamins and minerals to the body, whether it is through a general multivitamin or a single nutrient supplement. They are regulated to an extent by the FDA and are designed to easily and effectively be absorbed and utilized by the body.

Critics of supplementation often cite the lack of consistent regulation of extra ingredients and fillers, ingredient quality, and nutritional and medical claims for supplements as reasons they can be considered an expensive waste of money and a potential health hazard for consumers. For example, research shows that capsules are not the most effective way to deliver supplements based on what is known about digestion. Specific nutrients are absorbed at different parts of the digestive tract, and if they are released too early in digestion from a tablet or capsule, they will most likely be excreted without being absorbed. However, if the manufacturer puts effort into the supplement delivery method to plan for this, then supplements can be highly effective.

DIETARY SUPPLEMENTS:

Ingredients like vitamins, minerals, amino acids, herbs, or botanicals that can be used to supplement a diet.

FOOD AND DRUG ADMINISTRATION (FDA):

An agency under US Health and Human Services that is responsible for protecting public health by ensuring the safety, efficacy, and security of human and veterinary drugs and supplements.

FOOD AND SUPPLEMENT LABELING

While most common household products have a list of ingredients and some also have calorie and nutrients-per-serving information listed on the package, most fresh and whole foods do not have a package to list this information on. Figuring out just what each food supplies can develop into a full-time job and therefore requires nutritional training on the part of the consumer. Nutrition coaches should start learning what foods are good sources of the nutrients required by the average person and understand the dietary guidelines so they can easily relay it to their clients. This knowledge comes from reading the nutrition labels of products that have **nutrition facts** and supplement facts labels and using the many credible online resources available for those that do not. Instructors should start keeping track of what they eat and teach clients to do the same. Reading labels not only keeps coaches aware of what they are consuming but promotes better food choices when they have attention to detail.

NUTRITION FACTS:

A label required by the FDA on most food and beverages that details the food's nutrient content..

Under the FDA nutrition labeling regulations, certain ingredients and nutrition information must be listed on most packaged foods and supplements. Food labels will have ingredient listings and other nutritional information, such as the amount of fat, protein, carbohydrates, and certain vitamins and minerals. The only vitamins and minerals required to be listed on a food label are vitamin D, calcium, potassium, and iron. If a vitamin or mineral claim is made or it is added to the product, then it must also be listed on the nutrition panel. An **ingredient list** will name each ingredient in descending order of amount, with the first ingredient being the largest. If water is the first ingredient, then water is the most prominent ingredient. The exact amount of each ingredient will not be provided in the ingredient list.

INGREDIENT LIST:

A list provided on a food label of each ingredient in a product in descending order of prominence.



DID YOU KNOW

Not all foods require a nutrition facts panel? Recently, some companies have opted to include a nutrition facts panel due to the ever-growing concern the public has about calories and macronutrient profiles. A whole food product, such as an apple or banana, does not require a label. Additionally, retailers whose sales of foods or dietary supplements to consumers do not exceed \$50,000 in total sales do not require nutrition facts labels.



UNDERSTANDING FOOD AND SUPPLEMENT LABELS

The FDA has extensive regulations regarding every aspect of ingredients, packing, manufacturing, labeling, testing, and all processes related to the foods and supplements under their legal authority. Regarding labeling, there are requirements such as the appearance and organization of labels, proper terminology, legal ingredients, text formatting, and use of legal and nutritional claims that must be met. The following provides the basic requirements of food labeling for the **principal display panel (PDP)** and the information panel.

PRINCIPAL DISPLAY PANEL (PDP):

The part of a package label most likely to be displayed, shown, or examined under normal conditions on a retail display.

Figure 15.1 The Principle Display Panel

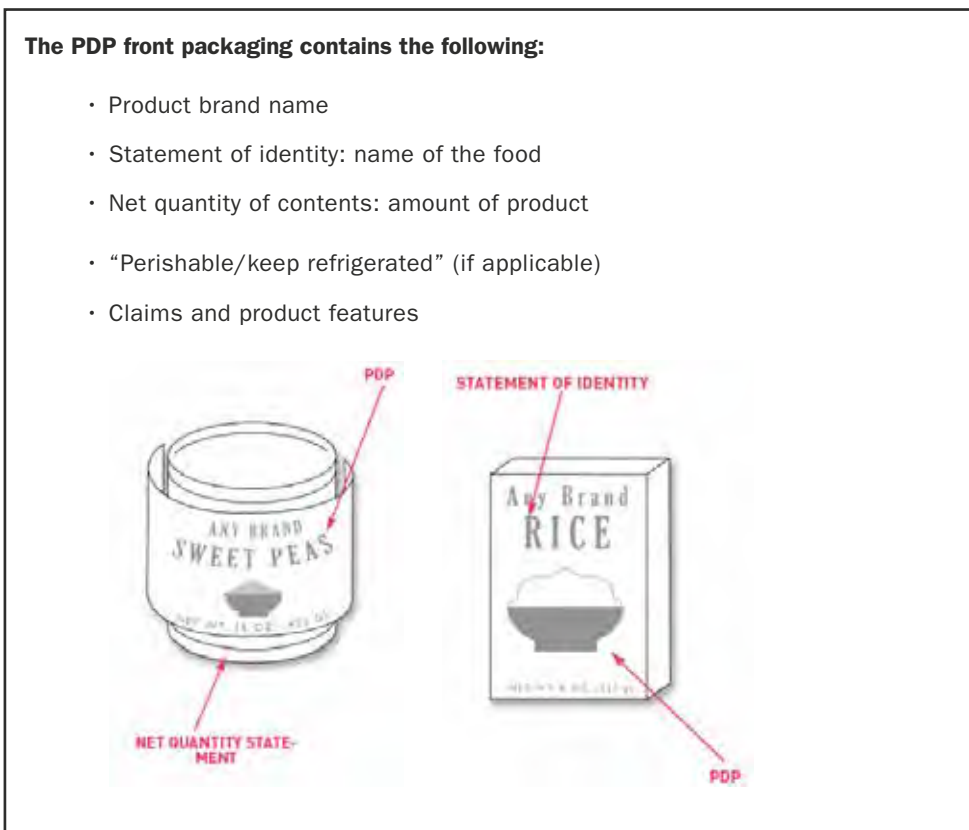
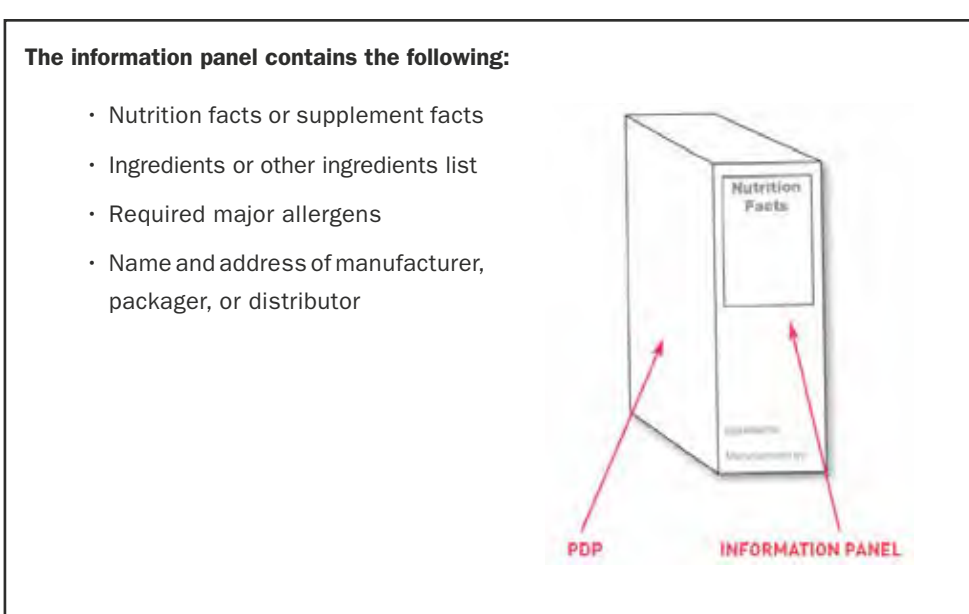


Figure 15.2 The Information Panel



REQUIREMENTS FOR SUPPLEMENT MANUFACTURERS

While it is assumed that dietary supplements are not regulated by the FDA, most companies must adhere to quality and efficacy testing requirements by the FDA and other governing bodies. Unless excluded, supplement manufacturers are required to maintain a food facility license with the FDA and are subject to audits without notice.

Testing requirements include but are not limited to ingredient identity testing, purity testing (such as the presence of safe levels of heavy metals), and dosage claims. Other possible testing requirements include expiration date testing and regularly scheduled testing of raw materials for each of the ingredient suppliers used.

DID YOU KNOW

That making a claim about a product requires intense and expensive testing? For this reason, most supplement companies opt to make claims about specific ingredients a product contains at a dosage at or below what is used per day. Done appropriately, these claims are made based upon existing scientific research that has been made available to the public.

NUTRITION FACTS LABELS

The nutrition facts label is designed to provide information that can help consumers make informed choices about the food they purchase and consume. The FDA seeks to protect and inform the consumer by making the label conveniently located on packaging, easy to read, and precise in its details.



Easy to Read

Current nutrition facts labels have been updated to make them easier to read. The original look of the label remains, but there are important updates including the bolding and increase in text size for details like serving size, calories per serving, and servings per container.

Manufacturers must declare the amount, in addition to percent daily value (% DV), of vitamin D, calcium, iron, and potassium in each serving of a product. Daily values are reference amounts of nutrients to consume or not to exceed and are used to calculate the percent daily value that manufacturers include on the label. They can voluntarily declare the gram amount for other vitamins and minerals if they are present or added to the product as well.

The footnote has been updated to better explain what percent daily value means. It will read: “*The % daily value indicates how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.”

Figure 15.3 Revisions to the Labels

FORMER LABEL	REVISED LABEL
 <p>The former label shows a standard Nutrition Facts panel. It lists 'Amount Per Serving' with 'Calories 230' and 'Calories from Fat 72'. It includes values for Total Fat (18g, 12%), Saturated Fat (1g, 5%), Trans Fat (0g), Cholesterol (0mg, 0%), Sodium (160mg, 7%), Total Carbohydrate (37g, 12%), Dietary Fiber (4g, 16%), Sugars (1g), and Protein (3g). It also lists Vitamin A (10%), Vitamin C (15%), Calcium (20%), and Iron (45%). A footnote states: '*Percent Daily Values are based on a diet of other people's misdeeds. Your daily value may be higher or lower depending on your calorie needs.' Below this is a table comparing 'Total Fat', 'Saturated Fat', 'Sodium', and 'Total Carbohydrate' to 'Less than' and 'More than' values.</p>	 <p>The revised label shows a more compact Nutrition Facts panel. It lists 'Amount per serving' with 'Calories 230'. It includes values for Total Fat (18g, 10%), Saturated Fat (1g, 5%), Trans Fat (0g), Cholesterol (0mg, 0%), Sodium (160mg, 7%), Total Carbohydrate (37g, 13%), Dietary Fiber (4g, 14%), Total Sugars (12g), and Includes 10g Added Sugars (20%). It also lists Protein (3g), Vitamin D (20%), Calcium (20%), Iron (45%), and Potassium (25%). A footnote states: '*The % Daily Values are based on a diet of other people's misdeeds. Your daily value may be higher or lower depending on your calorie needs. A daily diet of 2,000 calories is used for general nutrition advice.'</p>
<p>Note: The images above are meant for illustrative purposes to show how the revised nutrition facts label might look compared to the old label. Both labels represent fictional products.</p>	

Added sugars, in grams and as the percent daily value, are now included on the nutrition facts label. Scientific data shows that it is difficult to meet nutrient needs while staying within calorie limits if more than 10 percent of total daily calories are consumed through added sugar, and this is consistent with the 2015–2020 Dietary Guidelines for Americans.

ADDED SUGARS:
Sugars and syrups added to foods or beverages when they are processed or prepared.

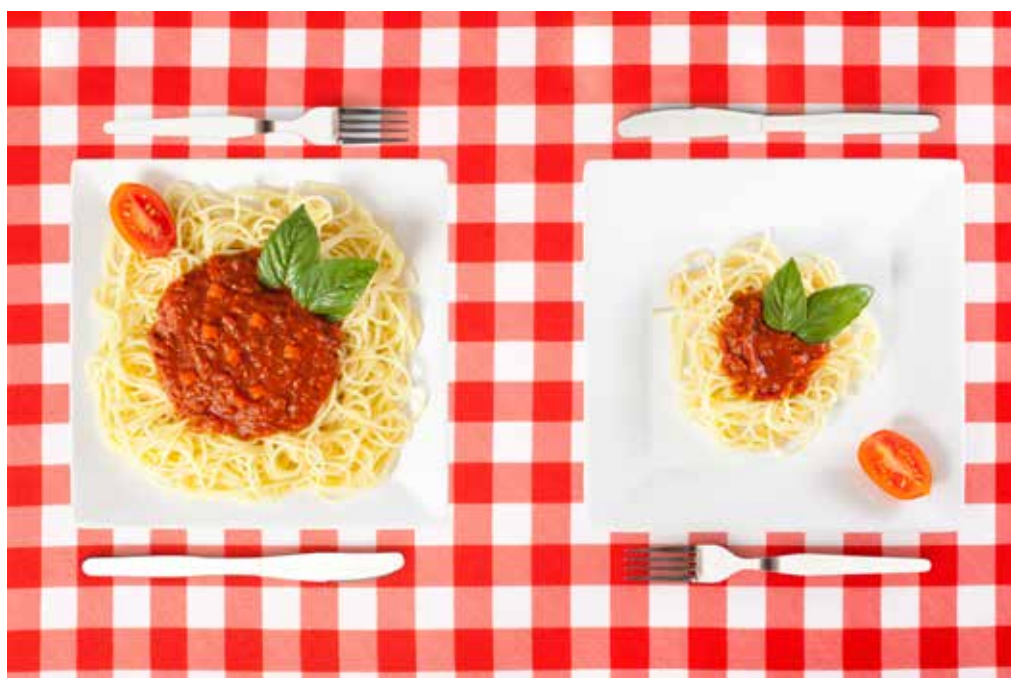
Also required are the amounts of vitamin D, potassium, iron, and calcium. Any other listed vitamins and minerals are optional. While continuing to require “total fat,” “saturated fat,” and “trans fat” on the label, “calories from fat” is no longer listed. The importance lies in the type of fats consumed versus the calories from fat.

Daily values for nutrients like sodium, dietary fiber, and vitamin D are being revised based on newer scientific evidence from the Institute of Medicine and other reports, such as the 2015 Dietary Guidelines Advisory Committee Report, which was used in developing the 2015–2020 Dietary Guidelines for Americans. The percent daily value helps consumers understand the nutrition information in the context of a total daily diet of 2,000 calories, unless otherwise specified on the label.

Updated Serving Sizes and Labeling Requirements

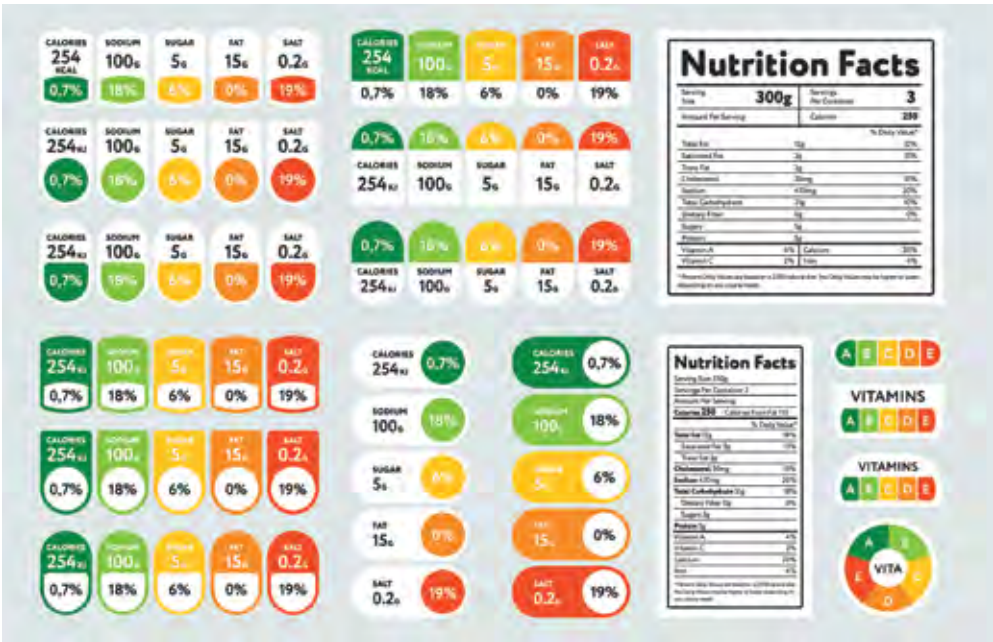
By law, serving sizes must be based on amounts of foods and beverages that people are actually eating, not what they should be eating. The amounts people consume for a serving have changed over time, and a reference amount is a standard used to determine serving sizes by the FDA. For example, the reference amount for a serving of ice cream was previously half of a cup but is now two-thirds of a cup, and the reference amount for a yogurt cup has decreased from eight ounces to six ounces.

Figure 15.4 How Serving Sizes Have Changed



Package size affects what people eat, so for packages that are between one and two servings, such as a 20-ounce soda or a 15-ounce can of soup, the calories and other nutrients will be required to be labeled as one serving. If the package is larger, the addition of another column with the words “per package” details the nutritional values if the entire package is consumed at once, as well as the reference amount for a single serving.

Figure 15.5 The Many Representations of Nutrition Facts



DID YOU KNOW

That nutrition labeling in the United States is quite different from nutrition labeling in Europe?

Table 15.1 Differences between Nutrition Labeling in the United States and Europe

UNITED STATES LABELING STANDARD	EUROPEAN LABELING STANDARD
Nutritional labels are based on a serving size	Nutritional labels are based on 100 grams or 1 milliliter of a product
Sodium, which includes salt as well as ingredients like baking soda, is listed in milligrams	Salt, which is specifically a mineral made of sodium chloride, is listed in grams
Additives in foods must be listed by their common names; if any imports to the United States don't have this, they will be blocked until the packaging is updated	Additives in foods must be listed by their "E numbers"

Defining Added Sugars

The definition of added sugars includes sugars that are either added during the processing of foods, or are packaged as such, and include sugars (free, mono-, and disaccharides) from syrups and honey, and sugars from concentrated fruit or vegetable juices that are in excess of what would be expected from the same volume of 100 percent fruit or vegetable juice of the same type. The definition excludes fruit or vegetable juice concentrated from 100 percent fruit juice that is sold to consumers (for example, frozen 100 percent fruit juice concentrate) as well as some sugars found in fruit and vegetable juices, jellies, jams, preserves, and fruit spreads.

Trans Fats on the Label

Trans fat will be reduced but not eliminated from foods, and the FDA will continue to require it on the label. The FDA has determined that partially hydrogenated oils (PHOs), the source of artificial trans fat, are not generally recognized as safe, but this determination would not affect naturally occurring trans fats, which would still exist in the food supply. Trans fat is present naturally in food from some animals, mainly ruminants such as cows and goats. Also, the industry can currently use some oils that are approved as food additives and can still petition the FDA for certain uses of PHOs.

TRANS FAT:

An unsaturated fatty acid in margarines and oils that is the result of hydrogenation.

The Addition of Vitamin D and Potassium

Vitamin D and potassium are nutrients Americans lack on a regular basis, according to nationwide food consumption surveys, and are associated with increased risk of chronic disease when not part of a healthy eating pattern. Vitamin D is important for its role in bone health, and potassium helps to lower blood pressure. Calcium and iron are already required and shall remain listed on the label.

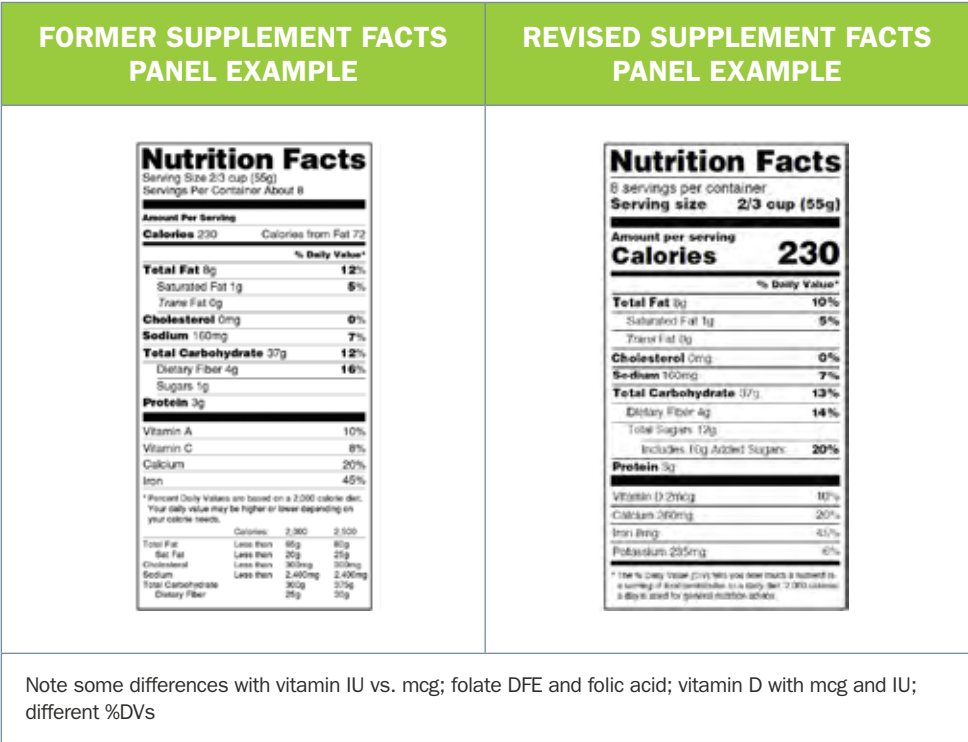
No More Vitamin A and C on the Label

In the past, vitamin A and C deficiencies were far more common; however, they are now extremely rare. While no longer required, manufacturers are still able to list these vitamins voluntarily on a nutrition label.

SUPPLEMENT FACTS LABELS

The supplement facts label is very similar to the nutrition facts panel as far as providing pertinent information to the consumer about a product. All included vitamins and minerals and their amounts per serving are listed as well as additional ingredients involved in the processing of the supplement.

Figure 15.6 Revisions to Supplement Facts Labels



DID YOU KNOW

Most dietary supplement ingredients do not have a recommended dietary allowance? If an ingredient does not have a recommended amount, an asterisk will be listed in its place, and at the bottom of the label below the supplement facts it will state “daily values not established.”

THE FDA AND THE FEDERAL TRADE COMMISSION

Outside of the way the FDA regulates food packaging, there are also regulations on the claims and statements in food marketing and packaging designed to protect consumers. Marketing can be incredibly powerful. Claims regarding “miracle” foods and health-enhancing added ingredients for specific long-term health benefits can influence the way consumers shop and buy foodstuffs. The FDA is primarily concerned with regulating claims on the product labeling, packaging, inserts, and other promotional materials directly associated with the products while the **Federal Trade Commission (FTC)** is primarily concerned with regulating claims in advertisements and marketing. It is thought that the regulation of the FDA is a higher standard, as they aim to keep consumers from being misled, versus the FTC’s mission to inform the public within a reasonable measure.

FEDERAL TRADE COMMISSION (FTC):

A US government agency that aims to protect consumers by enforcing consumer protection and antitrust laws.

FOOD AND SUPPLEMENT CLAIMS

Three categories of claims can be made on foods and dietary supplements: health claims, nutrient content claims, and structure or function claims. It is the responsibility of a product producer or manufacturer to understand the regulations behind the claims they make on a product. They have an obligation to provide claims that are clear, truthful, and not misleading to the public. Any research needed to support a claim must be completed and made available to the FDA or FTC if requested as well.

NUTRIENT CONTENT CLAIMS

A **nutrient content claim** is a claim on a food product that directly or by implication characterizes the level of a nutrient in the food. Some examples of nutrient content claims include: “low fat,” “high in oat bran,” “good source of vitamin C,” or “contains 100 calories.”

The following tables are from the FDA’s Food Labeling Guide and provide additional details related to nutrient claim examples.

NUTRIENT CONTENT CLAIM:

Describes the quantity of a particular nutrient in a food.

Figure 15.7 Definitions of Nutrient Content Claims

CONTENT CLAIMS (“FREE,” “LOW,” “REDUCED/LESS”)

Free

- ▶ Synonyms for “Free”: “Zero,” “No,” “Without,” “Trivial Source of,” “Negligible Source of,” “Dietarily Insignificant Source of”
- ▶ Definitions for “Free” for meals and main dishes are the stated values per labeled serving but are not defined for calories

Low

- ▶ Synonyms for “Low”: “Little” (“Few” for calories), “Contains a Small Amount of,” “Low Source of”

Reduced/Less

- ▶ Synonyms for “Reduced/Less”: “Lower” (“Fewer” for calories)
- ▶ “Modified” may be used in statement of identity
- ▶ Definitions for meals and main dishes are the same as for individual foods on a per 100 g basis

Comments

- ▶ For “Free,” “Very Low,” or “Low,” must indicate if food meets a definition without benefit of special processing, alteration, formulation or reformulation; for example, “broccoli, a fat-free food” or “celery, a low-calorie food”

DID YOU KNOW

That “calorie free” on a label is not always an accurate description of calories contained within the entire package? What it specifically indicates is that when the calorie count is less than 1 kcal, the food defaults to 0 on the label listing. When a nutrition coach is developing a client’s nutritional strategy, it is important that they consider how many calories a food contains in the serving size the client actually consumes.

Nutrient: Calories 21 CFR 101.60(b)

Free

- ▶ Less than 5 calories per RACC and per labeled serving (b)(1)

Low

- ▶ 40 calories or less per RACC (and per 50 g if RACC is small) (b)(2)
- ▶ Meals and main dishes: 120 calories or less per 100 g (b)(3)

Reduced/Less

- ▶ At least 25 percent fewer calories per RACC than an appropriate reference food (for meals and main dishes, at least 25 percent fewer calories per 100 g)
- ▶ Reference food may not be “Low Calorie”
- ▶ Uses term “Fewer” rather than “Less” (b)(4) & (5)

Comments

- ▶ “Light” or “Lite”: if 50 percent or more of the calories are from fat, fat must be reduced by at least 50 percent per RACC. If less than 50 percent of calories are from fat, fat must be reduced at least 50 percent or calories reduced at least 1/3 per RACC 21 CFR 101.56(b)
- ▶ “Light” or “Lite” meal or main dish product meets definition for “Low Calorie” or “Low Fat” meal and is labeled to indicate which definition is met 21 CFR 101.56(d)
- ▶ For dietary supplements: calorie claims can only be made when the reference product is greater than 40 calories per serving 21 CFR 101.60(a)(4)

Nutrient: Total Fat 21 CFR 101.62(b)

Free

- ▶ Less than 0.5 g per RACC and per labeled serving (or for meals and main dishes, less than 0.5 g per labeled serving) (b)(1)
- ▶ Contains no ingredient that is fat or understood to contain fat, except noted below (*).

Low

- ▶ 3g or less per RACC (and per 50 g if RACC is small) (b)(2)
- ▶ Meals and main dishes: 3 g or less per 100 g and not more than 30 percent of calories from fat (b)(3)

Reduced/Less

- ▶ At least 25 percent less fat per RACC than an appropriate reference food (or for meals and main dishes, at least 25 percent less fat per 100 g) (b)(4) & (5)
- ▶ Reference food may not be “Low Fat”

Comments

- ▶ “__% Fat Free”: may be used if food meets the requirements for “Low Fat” 21 CFR 101.62(b)(6)
- ▶ 100% Fat Free: food must be “Fat Free” (b)(6)(iii)
- ▶ “Light”—see previous calorie comments
- ▶ For dietary supplements: total fat claims cannot be made for products that are 40 calories or less per serving 21 CFR 101.62(a)(4)

Nutrient: Saturated Fat 21 CFR 101.62(c)

Free

- ▶ Less than 0.5 g saturated fat and less than 0.5 g trans fatty acids per RACC and per labeled serving (or for meals and main dishes, less than 0.5 g saturated fat and less than 0.5 g trans fatty acids per labeled serving) (c)(1)
- ▶ Contains no ingredient that is understood to contain saturated fat except as noted below (*)

Low

- ▶ 1 g or less per RACC and 15 percent or less of calories from saturated fat (c)(2)
- ▶ Meals and main dishes: 1 g or less per 100 g and less than 10 percent of calories from saturated fat (c)(3)

Reduced/Less

- ▶ At least 25 percent less saturated fat per RACC than an appropriate reference food (or for meals and main dishes, at least 25 percent less saturated fat per 100 g) (c)(4) & (5)
- ▶ Reference food may not be “Low Saturated Fat”

Comments

- ▶ Next to all saturated fat claims, must declare the amount of cholesterol if 2 mg or more per RACC; and the amount of total fat if more than 3 g per RACC (or 0.5 g or more of total fat per RACC for “Saturated Fat Free”) (or for meals and main dishes, per labeled serving) 21 CFR 101.62(c)
- ▶ For dietary supplements: saturated fat claims cannot be made for products that are 40 calories or less per serving 21 CFR 101.62(a)(4)

Nutrient: Cholesterol 21 CFR 101.62(c)

Free

- ▶ Less than 2 mg per RACC and per labeled serving (or for meals and main dishes, less than 2 mg per labeled serving)
- ▶ Contains no ingredient that contains cholesterol except as noted below (*) (d)(1)

Low

- ▶ 20 mg or less per RACC (and per 50 g of food if RACC is small) (d)(2)
- ▶ Meals and main dishes: 20 mg or less per 100 g (d)(3)

Reduced/Less

- ▶ At least 25 percent less cholesterol per RACC than an appropriate reference food (or for meals and main dishes, at least 25 percent less cholesterol per 100 g) (d) (4) & (5)
- ▶ Reference food may not be “Low Cholesterol”

Comments

- ▶ Cholesterol claims only allowed when food contains 2 g or less saturated fat per RACC; or for meals and main dish products, per labeled serving size for “Free” claims or per 100 g for “Low” and “Reduced/Less” claims
- ▶ Must declare the amount of total fat next to cholesterol claim when fat exceeds 13 g per RACC and labeled serving (or per 50 g of food if RACC is small), or when the fat exceeds 19.5 g per labeled serving for main dishes or 26 g for meal products
- ▶ For dietary supplements: cholesterol claims cannot be made for products that are 40 calories or less per serving

Nutrient: Sodium 21 CFR 101.61

Free

- ▶ Less than 5 mg per RACC and per labeled serving (or for meals and main dishes, less than 5 mg per labeled serving) (b)(1)
- ▶ Contains no ingredient that is sodium chloride or generally understood to contain sodium except as noted below (*)
- ▶ “Salt Free” must meet criterion for “Sodium Free” (c)(1)

Low

- ▶ 140 mg or less per RACC (and per 50 g if RACC is small) (b)(4)
- ▶ Meals and main dishes: 140 mg or less per 100 g (b)(5)
- ▶ “Very Low Sodium”: 35 mg or less per RACC (and per 50 g if RACC is small). For meals and main dishes: 35 mg or less per 100 g (b)(2) & (3)

Reduced/Less

- ▶ At least 25 percent less sodium per RACC than an appropriate reference food (or for meals and main dishes, at least 25 percent less sodium per 100 g)
- ▶ Reference food may not be “Low Sodium” (b)(6) & (7)

Comments

- ▶ “Light” (for sodium reduced 21 CFR products): if food is “Low Calorie” and “Low Fat” and sodium is reduced by at least 50 percent 21 CFR 101.56(c)(1)
- ▶ “Light in Sodium”: if sodium is reduced by at least 50 percent per RACC. 21 CFR 101.56(c)(2)
- ▶ For meals and main dishes, “Light in Sodium” meets definition for “Low in Sodium” 21 CFR 101.56(d)(2)
- ▶ “No Salt Added” and “Unsalted” must declare “This is Not A Sodium Free Food” either adjacent to the claim or on the information panel if food is not “Sodium Free” 21 CFR 101.61(c)(2)
- ▶ “Lightly Salted”: 50 percent less sodium than normally added to reference food and if not “Low Sodium,” so labeled on information panel 21 CFR 101.56(g)

Nutrient: Sugars 21 CFR 101.60(c)

Free

- ▶ “Sugar Free”: Less than 0.5 g sugars per RACC and per labeled serving (or for meals and main dishes, less than 0.5 g per labeled serving) (c)(1)
- ▶ Contains no ingredient that is a sugar or generally understood to contain sugars except as noted below (*)
- ▶ Disclose calorie profile (for example, “Low Calorie”)

Low

- ▶ Not defined
- ▶ May not be used

Reduced/Less

- ▶ At least 25 percent less sugars per RACC than an appropriate reference food (or for meals and main dishes, at least 25 percent less sugar per 100 g)
- ▶ May not use this claim on dietary supplements of vitamins and minerals (c)(5) & (6)

Comments

- ▶ “No Added Sugars” and “Without Added Sugars” are allowed if no sugar or sugar containing ingredient is added during processing. State if food is not “Low” or “Reduced Calorie” (c)(2)
- ▶ The terms “Unsweetened” and “No Added Sweeteners” remain as factual statements (c)(3)
- ▶ The claim does not refer to sugar alcohols, which may be present.
- ▶ For dietary supplements: “Sugar Free” and “No Added Sugar” may be used for vitamins and minerals intended to be used by infants and children less than two years of age ©(4)

Notes: * Except if the ingredient listed in the ingredient statement has an asterisk that refers to footnote (for example, “*adds a trivial amount of fat”).

- RACC = Reference Amounts Customarily Consumed
- Small RACC = Reference Amounts Customarily Consumed of 30 grams or less or 2 tablespoons or less (for dehydrated foods that are typically consumed when rehydrated with water or a diluent containing an insignificant amount, as defined in 21 CFR 101.9(f)(1), of all nutrients per RACC, the per-50-gram criterion refers to the prepared form of the food).

- When levels exceed 13 grams total fat, 4 grams saturated fat, 60 milligrams cholesterol, and 480 milligrams sodium per RACC, per labeled serving, or, for foods with small RACC, per 50 grams, a disclosure statement is required as part of claim (for example, “See nutrition information for content” with the blank filled in with nutrient(s) that exceed the prescribed levels).
- The term “light” may be used to describe a physical or organoleptic attribute of the food if it clearly conveys the nature of the product—for example, “light in color,” “light in texture.” 21 CFR 101.56(e)
- If there has been a long history of use of the term “light” associated with a product, it may continue to be used—for example, “light corn syrup,” “light brown sugar.” 21 CFR 101.56(f).

<http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm064911.htm>

<https://www.fda.gov/files/food/published/Food-Labeling-Guide-%28PDF%29.pdf>

Table 15.2

CLAIM	REQUIREMENTS
“High,” “Rich In,” or “Excellent Source of”	Contains 20 percent or more of the DV per RACC. May be used on meals or main dishes to indicate that the product contains a food that meets the definition but may not be used to describe the meal. 21 CFR 101.54(b)
“Good Source of,” “Contains,” or “Provides”	10–19 percent of the DV per RACC. These terms may be used on meals or main dishes to indicate that the product contains a food that meets the definition but may not be used to describe the meal. 21 CFR 101.54(e)
“More,” “Fortified,” “Enriched,” “Added,” “Extra,” or “Plus”	10 percent or more of the DV per RACC than an appropriate reference food. May only be used for vitamins, minerals, protein, dietary fiber, and potassium. 21 CFR 101.54(e)
“Lean”	On seafood or game meat products that contain less than 10 g total fat, 4.5 g or less saturated fat, and less than 95 mg cholesterol per RACC and per 100 g (for meals and main dishes, meets criteria per 100 g and per labeled serving). On mixed dishes not measurable with a cup (as defined in 21 CFR 101.12(b) in table 2) that contain less than 8 g total fat, 3.5 g or less saturated fat and less than 80 mg cholesterol per RACC. 21 CFR 101.62(e)(1)–(3)

CLAIM	REQUIREMENTS
“Extra Lean”	On seafood or game meat products that contains less than 5 g total fat, less than 2 g saturated fat, and less than 95 mg cholesterol per RACC and per 100 g (for meals and main dishes, meets criteria per 100 g and per labeled serving). 21 CFR 101.62(e)(4) & (5)
“High Potency”	May be used on foods to describe individual vitamins or minerals that are present at 100 percent or more of the RDI per RACC or on a multi-ingredient food product that contains 100 percent or more of the RDI for at least two-thirds of the vitamins and minerals with RDIs and that are present in the product at 2 percent or more of the RDI (for example, “High potency multivitamin, multimineral dietary supplement tablets”). 21 CFR 101.54(f)
“Modified”	May be used in statement of identity of a food that bears a relative claim (for example, “Modified fat cheesecake, contains 35 percent less fat than our regular cheesecake.”). 21 CFR 101.13(k)
“Fiber” claims	If a fiber claim is made and the food is not low in total fat, then the label must disclose the level of total fat per labeled serving. 21 CFR 101.54(d)(1)
Claims using the term “antioxidant”	For claims characterizing the level of antioxidant nutrients in a food <ul style="list-style-type: none"> • an RDI must be established for each of the nutrients that are the subject of the claim, • each nutrient must have existing scientific evidence of antioxidant activity, • the level of each nutrient must be sufficient to meet the definition for “high,” “good source,” or “more,” and • the name(s) of nutrient(s) that is (are) the subject of the claim is (are) included as part of the claim (for example, high in antioxidant vitamins C & E) 21 CFR 101.54(g)
“Fortified”	It is often believed that foods and supplements are always separate, but many foods are in fact “fortified” with supplements. While the consumer may assume the ingredient is naturally occurring, the use of vitamin D3 in whole milk is an example of a food that is fortified. Originally included in order to fight the rickets epidemic, D3 is now nationally recognized as an expectation within whole milk.

<http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm064916.htm>

HEALTH CLAIMS

Health claims are reviewed and authorized by the FDA. Health claims describe a relationship between a food substance (a food, food component, or dietary supplement ingredient), and reduced risk of a disease or health-related condition. A health claim differs from dietary guidance since dietary guidance does not link a substance and a health condition directly. Both are acceptable on food packaging when presented appropriately.

This is an example of a health claim: **“Three grams of soluble fiber from oatmeal daily in a diet low in saturated fat and cholesterol may reduce the risk of heart disease.”**

This is an example of dietary guidance: **“Consuming at least three ounces of whole grains per day can reduce the risk of several chronic diseases.”**

There is a clear difference between the two claims, and dietary guidance, if truthful and reasonable, does not require review by the FDA.

Separately, qualified health claims are similar to health claims but require scientifically researched results to support the claims made. Publicly available evidence must be used to support these types of claims. Some commonly found examples include calcium as part of a balanced diet to prevent osteoporosis, low dietary saturated fat and cholesterol can reduce heart disease, or low sodium diets and their positive effect on blood pressure.

STRUCTURE AND FUNCTION CLAIMS

Structure and function claims have historically appeared on the labels of conventional foods, dietary supplements, and drugs. There are many regulations to follow for using structure and function claims and two related types of dietary supplement labeling claims: claims of general well-being and claims related to a nutrient deficiency disease.

Structure and function claims may describe the role of a nutrient or dietary ingredient intended to affect the normal structure or function of the human body. An example of this is the claim that “calcium builds strong bones.” In addition, they may characterize how a nutrient or dietary ingredient acts to maintain such structure or function; for example, “fiber maintains bowel regularity,” or “antioxidants maintain cell integrity.”

General well-being claims describe general well-being from consumption of a nutrient or dietary ingredient. Nutrient deficiency disease claims describe a benefit related to a nutrient deficiency disease (like vitamin C and scurvy), but such claims are allowed only if they also establish how prominent the disease is in the United States.

HEALTH CLAIMS:

Any claim that states, suggests, or implies a relationship between a food and a constituent of health.

STRUCTURE AND FUNCTION CLAIMS:

A claim that describes the relationship between a nutrient deficiency and disease or how a dietary ingredient affects the structure or function of humans.

DISCLAIMER:
A statement to limit the scope of obligation, rights, or liability of the manufacturer.

If a dietary supplement label includes such a claim, it must state in a **disclaimer** that the FDA has not evaluated the claim. The disclaimer must also state that the dietary supplement product is not intended to “diagnose, treat, cure, or prevent any disease,” because only a drug can legally make such a claim. It is through this notification process that the FDA has the chance to review the structure and function claims a company is using on their product labels, and the FDA will contact a company if they have issues with a claim being made with lacking evidence or foundation.

Structure and function claims for conventional foods focus on effects derived from nutritive value, while structure and function claims for dietary supplements may focus on non-nutritive as well as nutritive effects. The FDA does not require conventional food manufacturers to notify them about their structure and function claims, and disclaimers are not required for claims on conventional foods.

More Common Claims Defined

TERM(S)	DEFINITION
“Pasture-Raised”	The animal was raised for some portion of its life on a pasture or had access to one. The label pasture-raised does not mean the animal lived in a grassy green field prior to being processed for consumption, and it is not verified or controlled by the USDA.
“Cage Free”	Cage free does mean the animal was not raised in a cage, but it may have been raised in close quarters. Chickens that are “cage free” are often kept in 8” x 8” spaces in a large shelter. The USDA does aim to verify this claim on food products like eggs, but they rarely inspect the facilities that house chickens to confirm the conditions.
“Locally Grown”	There is no standard definition for this claim on foods. Local could mean 5 miles away or 150 miles away based on the producer’s definition of the term.

TERM(S)	DEFINITION
“Free Range”	One would think this means the animals were loose in a large space as they grew, but there are no standards as to the size or condition of outdoor space that animals used for food are provided. Specifically with beef, the term free range means the animal was given access to some type of outdoor space for 120 days out of each year of its life.
“All Natural”	According to the USDA, a natural product contains no artificial ingredients or added colors and is minimally processed. However, this is not a verified label, meaning it can be placed on basically any product. These foods can also contain added nutrients like sodium or potassium as well as preservatives.
“No Sugar Added”	Most individuals see this and assume the sugar content is low. One glance at the nutrition panel will prove otherwise. These products are not calorie or carbohydrate free. The product will still contain whatever sugars are in the ingredients but will not include added sugars like maltodextrin.
“Light”	Consumer beware with light foods. This simply means that the product must contain 50 percent less fat than a comparable product, not that it is low in fat or calories.
“Cholesterol Free”	A misstatement commonly found on food packaging. Reduced cholesterol products are required to have 25 percent less cholesterol than a comparable product to bear this label. It does not mean the food as a whole has no cholesterol in it.

ORGANIC AGRICULTURE IN THE UNITED STATES

According to the United States Department of Agriculture, organic agriculture produces products using methods that preserve the environment and avoid most synthetic materials, such as pesticides and antibiotics. USDA organic standards describe how farmers grow crops and raise livestock and which materials they may use.

Organic farmers, ranchers, and food processors follow a defined set of standards to produce organic food and fiber. Congress described general organic principles in the Organic Foods Production Act, and the USDA defines specific organic standards. These standards cover the product from farm to table, including soil and water quality, pest control, livestock practices, and rules for food additives. Organic farms and processors

- preserve natural resources and biodiversity;
- support animal health and welfare;
- provide access to the outdoors so that animals can exercise their natural behaviors;
- only use approved materials;
- do not use genetically modified ingredients;
- receive annual onsite inspections; and
- separate organic food from nonorganic food.

PROCESSED FOODS:

food items that have had mechanical or chemical operations performed on them to preserve or alter them.

DID YOU KNOW

That **processed foods** generally taste great, which keeps consumers coming back for more? Scientists speculate that the reason people crave snack foods is due to their high nutrient profile of fat, simple carbohydrates (sugars), and sodium that were not common when humans depended on hunting and gathering their food. To compensate for this, research suggests humans have developed innate cravings that, once triggered, drive them to consume large amounts of food containing these nutrients. Artificial sweeteners and high sugar candies have a similar effect on the hormones that signal hunger and satiety like leptin and ghrelin. Processed and artificial ingredients can trick the body into thinking it is hungry, resulting in the excessive calorie intake that plays a large role in the obesity epidemic in America.

ORGANIC CLAIMS AND LABELING IN THE UNITED STATES

An increasingly common claim found on produce, meats, and fresh and processed foods are the organic labels. The USDA regulates the use of this term on foods and has developed variations to accommodate products that are not 100 percent organic.

To be “100 percent organic” in the United States, the product shall not be made with or contain any product that has been treated with or grown in soil containing chemicals, herbicides, or pesticides. The term “organic” describes a product with at least 95 percent organic ingredients and is also supported with a USDA seal to verify.

When a product is “made with organic ingredients,” no USDA seal is provided, and at least 70 percent of the ingredients must be organic.

An important note about organic land in the United States is that it only has to be chemical free for three years before an organic crop is harvested from it to be claimed as “organic farmland.” Organic seeds for food like grain, edible produce, and beans are typically used on organic farmland, but it is not required if the sprouts of the plant themselves are not consumed. So long as a farmer makes a reasonable effort to locate organic seed, if they cannot find any, they can use whatever is available.

Figure 15.8 Organic Labels

100% Organic	Organic	Made with Organic	Organic Ingredients
✓ Organic seal allowed	✓ Organic seal allowed	✗ Organic seal NOT allowed. Must specify which ingredients are organic	✗ Organic seal NOT allowed. Product can't be described as "organic"
✓ 100% certified organic ingredients and processing aids	✓ 95 % certified organic ingredients	✓ At least 70% certified organic ingredients	✗ No specific % certified organic
✓ No GMOs	✓ No GMOs	✓ No GMOs	✗ May contain GMOs
✓ All ingredients comply with National List of Allowed and Prohibited Substances	✓ Non-organic ingredients comply with National List	✓ Non-organic ingredients comply with National List	✗ Compliance with National List not required
✓ Certification required	✓ Certification required	✓ Certification required	✗ Certification NOT required

Learn more about organic labels at www.ams.usda.gov/organic

Agricultural Marketing Service, April 2018
USDA is an equal opportunity provider, employer, and lender



SUPPLEMENTS

LEARNING OBJECTIVES

- 1 | Discuss delivery methods of supplemental nutrition.
- 2 | List the types of dietary supplements available to the public.
- 3 | Understand the general uses of the most common supplements.

HIDDEN HUNGER:

A term given to the nutritional deficiencies in people who consume adequate calories but inadequate micronutrients.

Nutrient deficiencies can occur even when food supplies and nutrient-rich foods are readily available. However, these deficiencies are exacerbated in communities where access is restricted. **Hidden hunger** is a term given to the nutritional deficiencies in people who consume adequate calories but inadequate micronutrients. Anthropological research has shown the average American diet does not resemble the “Dietary Guidelines for Americans” suggested by the US Department of Health and Human Services. The average diet often lacks fruits, vegetables, whole grains, and the micronutrients needed to ward off chronic disease and serious health issues.

For healthy individuals who participate in high levels of activity or sport, nutrient requirements are typically increased above the baseline to support their extra physiological function. Muscle contraction, cardiorespiratory activity, and an increased metabolism all demand higher energy intake to support an energy balance. Supplementation is a common way to bridge the nutritional gaps existing in an individual’s diet and support athletic activities.

Surveys completed by the National Health and Nutrition Examination Survey found more than half of all Americans take a nutritional supplement of some kind, mostly vitamins and minerals. A nutrition coach must understand the types of common supplements available as well as their functions and uses to be able to field client questions. It is outside the scope of practice for a nutrition coach to prescribe supplements or dosages, but they can educate clients on what is available to them or refer them to a physician or licensed dietitian.

WHAT IS A DIETARY SUPPLEMENT?

Before 1994, dietary supplements had not been officially defined. The Dietary Supplement Health and Education Act of 1994 defined a dietary supplement as a product taken by mouth containing a “dietary ingredient” intended to supplement the diet and may include vitamins, minerals, herbs, botanicals, amino acids, enzymes, or extracts.

Supplements are not drugs. Drugs are regulated by the FDA and are intended to diagnose, treat, or cure diseases while supplements simply provide additional nutrients. However, an important similarity is that both are intended to affect the structure and function of the body.

Supplements also differ from food nutrition. Foods are not intended to affect the body’s structure or function but support its energy needs. Dietary supplements are not intended for use as food, or a meal, as part of a healthy eating pattern.

Table 16.1 Food versus Supplements

FOOD NUTRIENTS	DIETARY SUPPLEMENT NUTRIENTS
Random amounts in the diet	Generally controlled, consistent amounts
Nutrients supplied indiscriminately	Target specific requirements
Small, inconsistent nutrient amounts	Concentrated, specific nutrient amounts
Varied bioavailability	Designed to be highly bioavailable
Contain calories, wanted and unwanted	Contain no calories or controlled caloric content
May dislike food supplying nutrients	No taste to tablet-type supplements
Costly, time-consuming, perishable	Convenient, long shelf life
Often more expensive on a nutrient basis	Often less expensive on a nutrient basis
Usually no instructions	Label/manufacturer use instructions
May have to overeat to get the nutrients needed	Nutrient dense, can avoid overeating unwanted calories
Mandatory to eat healthy foods	Strategic nutritional use

TYPES OF SUPPLEMENTS

There are several types of supplements available to the public:

- ▶ Vitamins and minerals
- ▶ Botanicals (herbals)
- ▶ Sports nutrition
- ▶ Weight management
- ▶ Specialty

SUPPLEMENT FORMS AND DELIVERY

Supplements come in many forms or **delivery systems**, including these:

- ▶ Tablets
- ▶ Capsules
- ▶ Softgels
- ▶ Liquids and tinctures
- ▶ Powders
- ▶ Bars
- ▶ Beverages
- ▶ Extracts

DELIVERY SYSTEMS:

The forms in which a supplement enters the body for absorption.

Capsules versus Tablets

Liquid capsules come in two forms: hard-shelled and softgel capsules. Softgel capsules are easily broken down in the body, and the liquid content within the capsules reaches the bloodstream quickly after ingestion. The hard-shelled capsules are formed by two pieces fastened together with the liquid/active ingredients positioned in the middle.

Tablets are made from granulated powder ingredients tightly pressed together to formulate a hard pill. Tablets are either coated with a layer of sugar or film or are uncoated. Uncoated tablets are much tougher to swallow and at times leave an aftertaste in the mouth. A coated tablet is typically much easier to swallow and has less aftertaste.

Liquid-filled capsules are absorbed quicker into the body than tablets. The liquid is broken down and absorbed into the bloodstream within minutes, whereas tablets can take 20–30 minutes to be dissolved and absorbed. Liquid capsules are easier to swallow than uncoated tablets and typically do not leave an aftertaste.

VITAMINS AND MINERALS

Vitamin and mineral supplements can come in several forms: single mineral, single vitamin, or multiple vitamin. Single-vitamin and single-mineral supplements such as vitamin C and zinc contain just one compound and are intended to increase its intake. Multiple-vitamin supplements, commonly referred to as **multivitamins**, include two or more compounds, for example vitamin B complex or a women’s multivitamin.

MULTIVITAMINS:

A supplement containing two or more vitamins or minerals or both.

Figure 16.1 A Multivitamin Label



When deciding on a good multivitamin supplement, medical professionals recommend finding one with the following specific components: vitamin D, magnesium, calcium, zinc, iron, folate, and vitamin B₁₂. These are the most commonly deficient nutrients in people's diets and can help close the nutrient gap.

SPORTS NUTRITION

In sports nutrition, anabolic steroids, creatine, and protein supplements are the most referenced. Each have been found to improve athletic performance and recovery, but not all are legal in the United States.

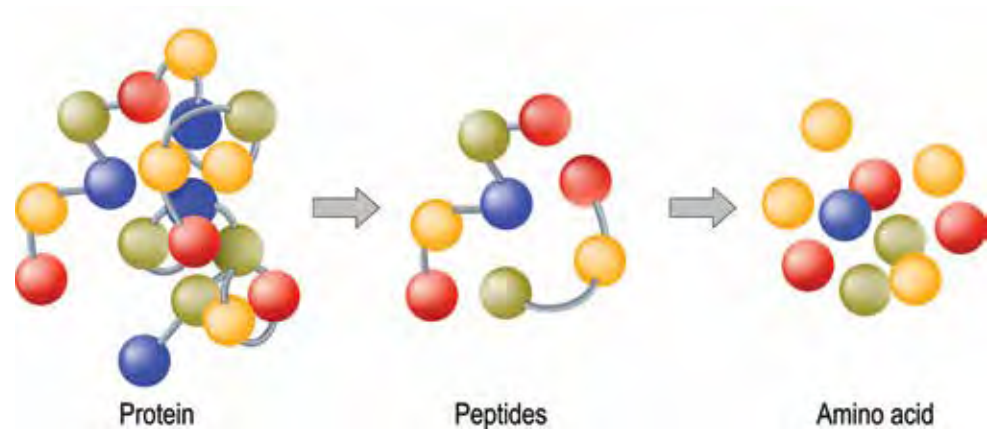
AMINO ACIDS AND PROTEIN

Proteins are continuously broken down in the body, transformed, and rebuilt. Proteins consist of a series of 20 amino acids, 9 of which are considered essential amino acids, and the remaining 11 of which are considered nonessential amino acids. Essential amino acids cannot be produced by the body, while nonessential amino acids can be produced. Therefore, consuming them in one's diet is not necessary.

The main role of amino acids is to build proteins needed by the body; however, they can also be metabolized in the liver and muscle to produce energy. This process requires most amino acids to be converted to glucose in the liver and then transported via the blood to the working muscle. Branched-chain amino acids (BCAAs), however, can be metabolized for energy directly within the muscle. It is for this reason BCAA supplementation has seen favor in recent years among fitness enthusiasts and athletes alike. Although BCAA supplementation is quite popular, they are readily available in whole foods such as these:

- Nuts
- Cheese
- Eggs
- Beans and lentils
- Meat, chicken, and fish
- Quinoa
- Pumpkin seeds

Figure 16.2 Proteins to Amino Acids



There are three common forms of commercially available supplemental protein: protein concentrates, protein isolates, and protein hydrolysates. Protein concentrates are produced by extracting protein from whole food using heat acid and enzymes. Protein isolates contain about 90–95 percent protein and have minimal lactose because the milk sugar is lost during the processing, and additional filtering removes more carbohydrates and fats. Protein hydrolysates are produced by heating with acids and enzymes, which helps break the bonds between amino acids. They are absorbed more quickly into the body and muscles and quickly affect insulin levels.

Protein supplements come from various sources as well, and the powder form is the most common. Protein powders can be combined with any type of liquid when they are consumed, and many people drink them from a cup or blend them with other ingredients such as fruits and vegetables for consumption.

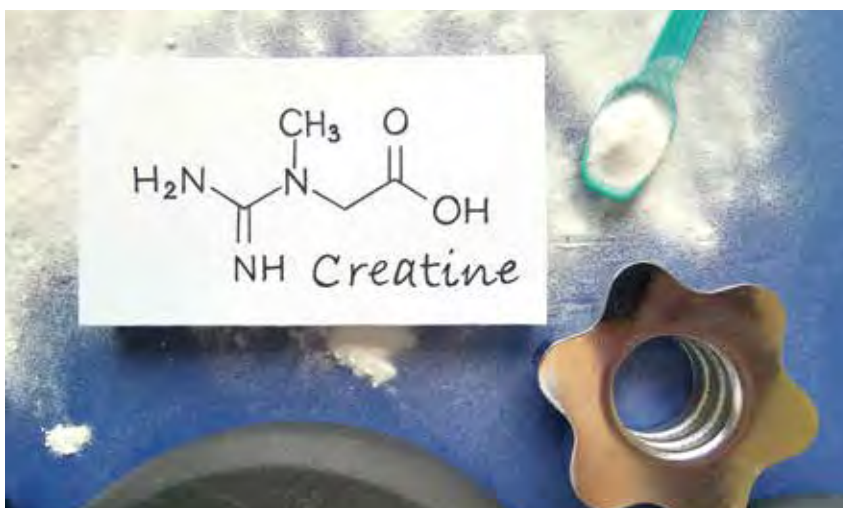
Table 16.2 Types of Protein Powders

PROTEIN TYPE	SOURCE	BENEFITS	DRAWBACKS
Whey	Milk	Contains leucine Digested quickly	Contains lactose (allergen)
Casein	Milk	Slow digesting Reduces muscle wasting post exercise	Contains lactose (allergen)
Pea	Yellow pea	Does not contain lactose Slower digesting	Not as bioavailable as milk-based protein

PROTEIN TYPE	SOURCE	BENEFITS	DRAWBACKS
Egg	Egg	High-quality protein Very bioavailable Complete protein source (all nine amino acids)	Allergen
Brown rice	Brown rice	Contains all essential amino acids	Low lysine Not bioavailable
Soy	Soybean	Contains all essential amino acids	Bioavailable at higher concentration

CREATINE

Creatine is a naturally occurring compound produced by the body to help muscles generate energy. It helps to increase ATP in the muscles, which in turn stores and transports energy in cells. Studies have shown supplementing creatine can help increase lean muscle mass and improve athletic performance in short bursts of power, such as sprinting, jumping, and weightlifting. However, there is a limitation to creatine supplementation as the muscles can only store so much, and it is only effective when it is being used. Research has shown simply taking creatine will not improve performance but requires sound training principles to elicit the potential performance benefits. Typical supplementation of this compound is four to six weeks with appropriate activity levels. Creatine users should follow the manufacturer's recommended dosing protocol and may want to consider consulting with a dietician or physician prior to use.



ANABOLIC STEROIDS:

Synthetic steroid hormones used to promote muscle growth and increase physical performance.

GLUCOCORTICOSTEROIDS:

Anti-inflammatory steroids such as prednisone and cortisone.

MINEROCORTICOSTEROIDS:

Steroids, such as vasopressin, prescribed for water retention.

ANABOLIC STEROIDS

Anabolic steroids are synthetic hormones resembling testosterone and used to increase muscle mass, strength, and speed. They have been found to reduce recovery time after workouts and increase the intensity at which the body can work for longer periods of time. Anabolic steroids cannot be purchased over the counter in the United States, but they can be prescribed by a physician to a client, thus making awareness of these steroids important.

Common anabolic steroids include testosterone, Winstrol, Deca-Durabolin, and Dianabol. These should not be confused with the **glucocorticosteroids** prednisone and cortisone, which are used as anti-inflammatories, or with **minercorticosteroids** such as vasopressin, which is prescribed for water retention.

The side effects of using steroids are often enough to deter many people, but the benefits are clear and proven.

Table 16.3 Side Effects of Anabolic Steroids

GENDER	SIDE EFFECTS
Women	<ul style="list-style-type: none">• Deeper voice• Enlarged clitoris• Increased body hair• Baldness• Absent periods (amenorrhea)
Men	<ul style="list-style-type: none">• Gynecomastia—development of breast tissue• Shrinkage of testicles• Infertility• Prostate gland dysfunction
Women and men	<ul style="list-style-type: none">• Susceptible to tendon rupture• Heart and blood circulation dysfunction• High blood pressure• Aggression• Liver abnormalities• Depression• High cholesterol levels

WEIGHT MANAGEMENT

A nutrition coach can recognize weight management is one of the most common goals of a nutrition or fitness program. This includes weight loss or gain and lifestyle or behavior changes with food. The supplements available to support the process of weight management have grown into a billion-dollar industry in the United States.

The most common weight-management supplements are referred to as **thermogenic supplements**, which work to increase the internal body temperature by one to two degrees to increase the overall calorie burn (metabolism). The most common ingredient in these supplements is caffeine, which can be highly addictive and have side effects like nausea, headaches, and indigestion. Other widely used ingredients in weight-management supplements include the following:

- Chromium
- Guar gum
- Chitosan
- Linoleic acid
- Green tea
- Hydroxycitric acid
- L-carnitine
- Pyruvate
- Saint John's Wort
- Chia seed

Medical research suggests clients taking these supplements should be monitored by a licensed health care provider. However, these types of supplements are readily available over the counter, and many consumers do not report taking them.

Another class of weight-management supplements works to suppress the appetite. The ingredients typically affect the brain pathways signaling hunger and are modified by physical satiation. Common ingredients typically found in appetite suppressant supplements are acacia fiber, guar gum, and chromium picolinate.

THERMOGENIC SUPPLEMENTS:

Weight-management supplements increasing the body temperature (metabolism).



NAVIGATING SUCCESSFUL AND TRENDING DIETS

LEARNING OBJECTIVES

- 1 | Define the term “diet” and explain how it applies to the role of a nutrition coach.
- 2 | Distinguish between a trend diet and a fad diet.
- 3 | Describe some of the common trending and fad diets.
- 4 | List the attributes of successful diets.

Fad diets gain popularity quickly and then disappear. Trending diets take a little longer to catch on, but they are often more lasting. Trend diets are more likely to be supported by results and research, which is why they gain popularity and have more staying power.

Nutrition coaches have a professional responsibility to stay up to date on both fad and trending diets to advise clients on the potential risks and benefits. However, the scope of practice of a nutrition coach is not to provide meal plans or to choose a diet but to educate clients so they can make their own food choices. Clients interested in using a diet to address a medical condition should work with a licensed healthcare professional.

DEFINING “DIET”

DIET:

The foods that a person or community eats most often and habitually; a choice of regular foods consumed for the purpose of losing weight or for medical reasons.

The word **diet** originates from the Greek word *diaita*, meaning “way of life.” The initial meaning included everything that encompasses a lifestyle. Today the term has a more limited meaning. It describes the foods that a person habitually eats, whether it be to lose weight, to maintain or improve health, or for medical reasons.



Many people use the term diet to refer to a pattern of eating with the goal of rapid weight loss, extreme physical transformation, or prevention of chronic disease. A well-balanced diet and consistent, healthy eating habits provide more stable health and weight benefits over time.

There are many different diet plans targeted to consumers. They promise a range of benefits:

- Rapid weight loss
- Long-term weight loss
- Improved gut health
- Lower risk of diabetes
- Improved cardiovascular health
- Lower blood pressure

To help guide clients, nutrition coaches must be aware of popular diets, the differences between fad and trend diets, and their risks and benefits.

FAD DIETS VERSUS TRENDING DIETS

Fads come in waves, appear quickly, have an enthusiastic following, and then often disappear very soon after emerging. For example, hula-hoops, the Macarena, and the beehive hairstyle were all fads that exploded and then fell out of style.

Trends gain momentum and popularity more slowly. They have staying power and are more likely to solve a problem or fill a need for a wide range of people. For example, there has been resistance when it comes to social media, video streaming, ridesharing, and grocery store self-checkouts, but they have steadily become the norm. They fill needs or make life easier in some way and are not in danger of disappearing soon.

Fashionable diets are plentiful, and some are fads while others are trends. Some diets have delivered everything they promise. The World Health Organization (WHO) has even recognized some popular diets as sustainable and healthy lifestyle choices. Other diets fall by the wayside because they don't deliver results or are harmful.

A nutrition coach must understand fad and trending diets and use research as a guide when consulting with clients.

FADS:

A short-lived enthusiasm or preference for something regardless of its merits or qualities.

TRENDS:

Ideas or things that slowly gain momentum, appeal to the masses, and solve a problem or fill a need.

FAD DIETS

Trend diets have staying power, but fad diets explode in popularity and then disappear very quickly. While some have foundations in sound, healthy practices, these diets often disappear because they don't yield promised results, are too risky, or have no research evidence to prove efficacy.

DETOX DIET

A detox diet is based on the idea that the body benefits from periodic detoxification. There is a lot of variety in detox diets, but they generally begin with a period of fasting followed by a strict diet of raw fruits and vegetables, water, or juices. The initial fast can range from two days to a week, followed by two to seven days of liquid or decreased calorie intake.

Also known as cleanses, detox diets claim to cleanse the body of toxins, refresh the digestive tract, and reset metabolism. Weight loss may be significant on a detox, but it is largely a result of water loss. Some individuals report a boost in energy during and after a detox. Science suggests this is a result of removing processed foods and sugars from the diet while reducing calorie intake. Short term, this can be beneficial, but detoxing for extended periods of time is contraindicated. There is no solid research to prove a cleanse or detox is necessary or beneficial unless ordered by a licensed health professional.

There are several popular cleanses, including the colon cleanse, juice cleanse, and the liver detox.

Colon Cleanse

The goal of a colon cleanse is to clear the digestive tract by increasing water intake, by using a **colonic**, or with supplements or laxatives. A colon cleanse can cause extreme discomfort, cramping, diarrhea, and electrolyte imbalances. It may also cause more serious bowel issues and heart problems. Most health professionals recommend eating more fiber rather than trying one of these dramatic types of detox.

COLONIC:

A procedure that uses fluids to flush the colon through the rectum.

Juice Detox

The juice detox follows a period of fasting with 2–21 days of a liquid diet. Commonly referred to as juicing, the juices can be fresh squeezed or prepackaged. While there are many benefits of consuming fruit and vegetable juices, the restrictions can cause nutritional deficits, especially of protein and fats.

Headaches, fatigue, dizziness, and muscle weakness have been reported for juice cleanses. Most health professionals recommend the addition of fruit and vegetable juice into a balanced diet instead of limiting consumption to just juice.

Liver Detox

Liver detoxes usually involve consuming large amounts of specific herbal teas: ginger, chamomile, mint, and turmeric. This is supposed to cleanse the liver after a two- to four-day fast. The liver is a natural filter in the body, and as such, it cleanses itself. A fast or tea detox is not necessary for the liver to function properly. The lack of calories and essential vitamins, minerals, and nutrients during a liver detox is problematic and can lead to fatigue, fainting, low blood sugar, brain fog, and weakness.

AMERICAN HEART ASSOCIATION (AHA):

A nonprofit organization that funds cardiovascular research and educates consumers on healthy living and good cardiac care.

LOW- AND NO-FAT DIETS

The **American Heart Association (AHA)** recommends that no more than 30 percent of daily calories come from fat. But, the safe lower limit for fat consumption has never been established. During the low-fat food trend, many manufacturers reduced fat in products like yogurt, cheese, milk, cereals, salad dressing, nut butters, pastries, frozen desserts, and butter substitutes. They replaced the fat with fillers, sugars, and chemicals for better taste, texture, and consistency. These artificial additives can cause gastrointestinal distress, digestion issues, and skin problems.

A very low-fat diet can initially lead to weight loss if calorie guidelines are followed. However, critics warn that the benefits are negated by decreases in plasma cholesterol levels and health issues for special populations like pregnant or lactating women, children, and the elderly.

It is also important to note that dietary fat is important for hormone production and regulation. A low-fat diet can upset hormone balance and cause health problems in both men and women.

EATING BY BLOOD TYPE

A popular diet in the early 2000s was the genotype or blood type diet. A naturopathic physician named Peter D'Adamo developed the diet after theorizing that a person's blood type determines how they respond to certain foods.

D'Adamo created a guide to eating by blood type:

- **Blood Type A:** People with this blood type should consume fruit, vegetables, tofu, seafood, soy, and whole grains, and avoid most meats. Ideally, their diet is

mostly vegetarian, with some fish, and largely organic and fresh because of a sensitive immune system.

- **Blood Type B:** People with this blood type should choose green, non-starchy vegetables (spinach, asparagus, green beans, artichokes), lean meats (except chicken), and low-fat dairy while avoiding corn, wheat, lentils, tomatoes, and peanuts. Because of digestive sensitivity, this diet is supposed to be largely gluten-free.
- **Blood Type AB:** AB types should focus on tofu, seafood, dairy, and green leafy vegetables while avoiding caffeine, alcohol, and cured meats. These individuals supposedly have low stomach acid.
- **Blood Type O:** Type Os should eat a diet of lean meats, poultry, fish, and vegetables while avoiding grains, beans, and dairy.

A study with more than 1,400 subjects found some interesting results. Regardless of their blood type, the participants were given a list of foods to choose from for a one-month period. Based on their natural food choices, researchers determined which of the blood type diets they most closely followed. Researchers also assessed the participants' cardiovascular health and made other physical health measurements.

Those who followed the Type A pescatarian diet had reductions in their BMI, waist circumference, blood pressure, cholesterol levels, and insulin resistance. The AB diet protocol showed reductions in blood pressure, cholesterol levels, and insulin resistance but no change in BMI or waist circumference. Type O meat-eating dieters had a reduction only in blood triglycerides, and Type B eaters showed no significant changes.

None of the research completed on genotype or blood type dieting supported the claims that a certain blood type responded more to a certain diet or that there were better results than an average calorie-restricted diet.

CABBAGE SOUP DIET

The specificity of the cabbage soup diet is the epitome of a fad. Popular in the 1980s, it is as simple as it sounds: consume a lot of cabbage soup. Dieters are also supposed to add in other vegetables, beef, chicken, and brown rice.

The weight loss reported on this diet mostly came from reduced calorie intake. Risks include high sodium intake from broth and poor overall nutrition with deficiencies in micronutrients.

RAW FOOD DIET

Proponents of the raw food diet believe that cooking foods to certain temperatures leaches nutrients and destroys proteins and enzymes. The diet is rich in foods like pressed fruit and vegetable juices, raw or dehydrated fruits and vegetables, raw nuts and seeds, raw and sprouted grains and legumes, and fermented items like sauerkraut and kimchi. Dieters may also eat raw eggs, fish, and some types of meat.

The raw diet is not marketed as a weight loss diet but a disease prevention plan. The main claim of proponents is that the diet improves enzyme activity and digestion, but this remains unproven.

Critics of the raw food diet have a lot of concerns, including the risks of eating raw and undercooked meat and animal products. Raw meats and animal products can carry pathogens like salmonella, E. coli, staphylococcus, and listeria. They can cause serious infections that may be fatal. For vegan raw dieters, deficits in some micronutrients, like B₁₂, may be an issue. Vitamin B12 is found in meat, chicken, dairy, and eggs and is a vital component for maintenance of the body's blood and nerve cells.

BABY FOOD DIET

Created by celebrity trainer Tracy Anderson, the baby food diet is exactly as it sounds. There are two options on this diet: use baby food as a meal replacement or as the sole type of food consumed.



For those choosing to consume only baby food, the recommendation is just 14 jars a day. This is a low-calorie diet, so weight loss is typical. However, baby food typically lacks fiber despite being generally healthy. It is also expensive to buy enough baby food to sustain an adult. Replacing one to two meals per day with baby food also reduces calorie intake significantly and may cause weight loss.

LOW-ENERGY DIET (LED) AND VERY LOW-ENERGY DIET (VLED)

Low- and very low-energy diets are physician supervised. A low-calorie diet is considered 800–1,200 calories daily while a very low-calorie diet is less than 800 calories daily. These diets can be successful for weight loss because of the drastic calorie restriction conducted in a clinical setting. Without guidance it is very difficult to adhere to these restrictions.

Clinical studies following individuals on LEDs and VLEDs found body weight reductions of 10–15 percent. These diets help with weight loss, weight maintenance, management of conditions like obesity, type 2 diabetes, sleep apnea, and cardiovascular disease.

Exercise is generally not recommended on low- and very low-calorie diets. Research has shown that weight loss and maintenance on these diets is most successful with higher protein levels and lower glycemic index foods. This allows blood sugar to stay relatively consistent, reduces blood insulin spikes for those with diabetes or prediabetes, and decreases hunger.

After the initial weight loss on LEDs and VLEDs, weight gain is typical without ongoing support. This is driven by downregulation of hunger hormones and the tendency to exceed the maximum calorie recommendations. Individuals are hungrier and feel less satisfied after eating and, without guidance, tend to overeat. The addition of reduced-calorie meal replacements and fortified formulas for the maintenance phase promotes satiety and prevents bingeing.

In some clinical settings, dieters may be able to maintain weight loss with one to three meal replacements (or formulas) daily to keep the calorie count as low as possible. Depending on the macronutrient makeup of the diet, some individuals achieved and sustained ketosis as a by-product of the diet.

CURRENT TRENDING DIETS

Current and trending diets make a lot of claims: fat loss, weight loss, and preventing or improving chronic disease, among others. Many of these diets have been researched to some extent to determine if the claims are true.

The following trend diets have staying power for various reasons. They may provide promised benefits or align with certain values. Nutrition coaches should understand the most common trend diets and their benefits and risks. With this information, they can guide clients to choose a diet that works best for their needs.

PLANT-BASED DIET:

Eating mostly or entirely foods that are plants or derived from plants.

PLANT-BASED DIETS

A **plant-based diet** minimizes, restricts, or completely leaves out meat and animal products. Research has shown that adopting a plant-based diet is not only cost-effective but can help lower body mass index (BMI), blood pressure, cholesterol levels, and heart disease risk factors. There are several variations of a plant-based diet.



Vegan

Vegans do not consume or use any animal products or by-products. This includes meat, poultry, game, fish, eggs, dairy, honey, and animal-derived food ingredients like gelatin. A vegan diet may be limited in omega fatty acids, vitamin B12, and folate. Vegans may need to supplement these nutrients.

Lacto-Vegetarian

This diet does not allow for any meat, poultry, fish, or eggs but does include dairy. Again, folate, vitamin B12, and omega fatty acids may be limited for lacto-vegetarians. Including dairy increases calcium intake, protects bones, and aids in muscle tissue functioning and metabolic processes.

Ovo-Vegetarian

An ovo-vegetarian eats eggs and foods with eggs as ingredients but not any dairy or meat. The inclusion of eggs makes up for the loss of some B vitamins. Eggs provide high-quality protein.

Lacto-Ovo Vegetarian

This is the most common type of vegetarian and what most people mean when using the term. Lacto-ovo vegetarians eat dairy and eggs but no meat, poultry, or fish.

Pescatarian

A diet that allows for dairy, eggs, fish, and other types of seafood is pescatarian. The name derives from the Spanish word for fish, pescado. Frequent fish consumption poses a risk of mercury exposure, but it is possible to choose types of seafood with less mercury. And there are benefits too: fish is a lean protein source, and fatty fish provides essential omega fatty acids.

Pollotarian

Derived from the Spanish word for chicken, a pollotarian diet includes dairy, eggs, and chicken as well as other poultry. Individuals on this diet must be careful to get enough iron, zinc, and vitamin B12 from foods or supplements.

Flexitarian

A flexitarian enjoys a mostly vegetarian diet but may occasionally consume any type of fish, poultry, or seafood. The diet is mostly plant-based but leaves room for animal products.

Between 2 and 5 percent of the US population is vegetarian or vegan. Plant-based diets are generally beneficial for overall health but do not necessarily improve weight loss. These diets are supported by researchers and health professionals and have no real adverse health effects.

Studies have shown that vegans have a decreased risk for diabetes, hypertension, and cardiovascular disease as compared to those who eat plant-based diets with some eggs, dairy, or meat.

Table 17.1 Plant-Based Eating Styles

PLANT-BASED TYPE	MEAT	GAME	POULTRY	FISH	EGGS	DAIRY	NOTHING ANIMAL-DERIVED
Vegan	No	No	No	No	No	No	Yes
Lacto-vegetarian	No	No	No	No	No	Yes	No
Ovo-vegetarian	No	No	No	No	Yes	No	No
Lacto-ovo-vegetarian	No	No	No	No	Yes	Yes	No
Pescatarian	No	No	No	Yes	Yes	Yes	No
Pollotarian	No	No	Yes	No	Yes	Yes	No
Flexitarian	No	No	Some	Some	No	No	No

KETOGENIC (KETO) DIET

The **keto diet** is also based on restricted carbohydrate intake. On the keto diet, only about 20 percent of daily calories come from carbs. This amounts to about 50 grams based on a 2,000-calorie diet.

The remaining calories are divided between fats (55–60 percent) and protein (30–35 percent). This is approximately 275–300 grams of protein and 66–77 grams of fats daily. Unlike Atkins, the carb intake does not increase over time.

If executed correctly, the keto diet will lead to a state of ketosis in the first week. Ketones are naturally produced as an energy source by the liver when insulin and glucose are low. They are a product of fat metabolism and can act to suppress appetite and fuel the body. Once ketosis is achieved, the goal is to consistently remain in this state.

Studies have shown that the benefits of keto include an increase in HDL cholesterol, a decrease in LDL cholesterol, lower blood glucose levels, and significant BMI reduction and weight loss. If carbohydrates are reintroduced in the diet, the results reverse.

Ketoacidosis is a dangerously high level of ketones in the blood. It requires immediate medical care. This extreme condition is usually caused by starvation, but it may be triggered by following a ketogenic diet.

KETO DIET:

A popular diet that reduces carbohydrate intake to deliberately increase fat metabolism and ketones in the blood.

KETOACIDOSIS:

An increase in blood acidity caused by excess ketones in the bloodstream.

The keto diet can also cause side effects similar to those of any low-carb diet: headache, fatigue, bad breath, constipation, and dehydration. A study done by the Harvard School of Public Health also connected carb-restrictive diets to an increased risk of kidney stones, osteoporosis, and increased blood levels of uric acid.

ATKINS DIET

The Atkins Diet is both a brand and a diet that has been popular for years. Food products made and packaged specifically for Atkins dieters are widely available and easy to find, making it a convenient choice.

The diet is very low in carbohydrates, with 90–95 percent of calories from protein and fats. For an average 2,000-calorie diet, this amounts to 1,800 calories a day from fat and protein and 200 calories daily from carbohydrates (50 grams or less).

Research has shown that low-carb diets such as this can increase metabolic output (basal metabolic rate) by 50–90 calories a day. But eating this way may also reduce the hormones leptin and ghrelin, which in turn increases appetite. These effects can be counteracted by reducing fat intake and increasing calories from protein sources to about 30 percent.

Critics of the Atkins diet say it causes low energy, impairs cognitive function, and increases gastrointestinal distress because of the high levels of fat. The first two weeks of the diet, the induction phase, limits carbohydrates to just 20–25 grams per day. This is intended to induce **ketosis**.

Phases two, three, and four slowly reintroduce carbohydrates back into the diet starting at 25–50 grams per day, finally going up to 100 grams per day for the long-term maintenance phase.

Despite the restrictions with Atkins, research has shown that adherence to the diet can improve **metabolic syndrome** and diabetes, reduce high blood pressure, and lower cardiovascular disease risk. Weight loss depends on the total calories consumed on the diet.

The risks of the Atkins diet have been studied, but the long-term health effects are still relatively unknown. It is too new to have enough data to make this determination. Health professionals generally have several concerns about a high-fat, low-carbohydrate diet:

- Deficiencies in trace minerals and vitamins
- Inadequate fiber
- No better long-term weight loss results than low-calorie diets

Additionally, there are side effects of a low-carb diet, including bad breath, headaches, fatigue, dizziness, constipation, and dehydration.

KETOSIS:

A metabolic process that occurs when the body does not have enough carbohydrates for energy; the liver metabolizes fatty acids to produce ketones as a replacement energy source.

METABOLIC SYNDROME:

A group of conditions that increase the risk of heart disease, stroke, and type 2 diabetes; these include obesity, high blood sugar, high blood pressure, decreased HDL, and high triglycerides.

CARNIVORE DIET

The carnivore diet consists of eating meat and **animal products** exclusively. Beef, lamb, pork, veal, chicken, and eggs are staples of the diet. Carnivore dieters avoid vegetables, low-lactose dairy, fruits, legumes, nuts, seeds, and grains. Carb restriction on the carnivore diet triggers ketosis. It is the ketogenic state that produces weight loss on this diet.

Supporters of the diet cite human evolution as support for the carnivore diet. They believe that because humans evolved as hunters, they are designed to eat and process meat and animal products.

Weight loss and ketosis are often considered the main benefits of the diet. Some people also report better digestive health and higher testosterone levels.

Long-term kidney damage from high protein intake are under investigation. Studies have shown that the carnivore diet can lead to higher blood serum fat levels over time. Critics of the diet also cite nutrient deficiencies, specifically plant-based vitamins and minerals, as a major issue. Additionally, high protein intake increases uric acid in the blood, which can lead to conditions like gout.

ANIMAL PRODUCTS:

Any material derived from the body of an animal, including dairy products, eggs, honey, and gelatin.

PALEO DIET

The Paleo diet has gained momentum in the past ten years and is popular among CrossFit and extreme sports athletes. Many people refer to it as “clean eating.” It differs from the carnivore diet by including fruits, vegetables, nuts, and seeds. Paleo dieters avoid dairy products, legumes, processed foods, and refined sugars. It is a simple plan based on ancestral hunting and gathering. It is generally low in carbohydrates and high in protein.

Figure 17.1 The Paleo Diet Pyramid



People who turn to the Paleo diet are usually looking to lose or maintain weight and to eat a simple, healthy diet. The simpler diet plan, along with avoidance of sugar and processed foods, naturally leads to a lower calorie intake.

Paleo has become very popular, and it is now easier to find related products in grocery stores and restaurants. However, purchasing a processed product for a diet that promotes unprocessed eating defeats the purpose. People truly interested in a strict Paleo diet should avoid consuming anything other than whole foods.

Studies show that this well-balanced approach can reduce overall weight without compromising muscle tissue. It has been shown to reduce bad cholesterol and blood triglycerides, lower blood pressure, and decrease resting insulin levels.

Critics raise concerns about the nutrition of the Paleo diet for active people and athletes. The avoidance of grains and carbs reduces energy levels. Studies of athletes have shown that individuals need between three and six grams of carbohydrates per pound of bodyweight to support their activity levels.

The diet is also challenging for vegetarians and vegans as eating legumes is discouraged. Legumes are a major protein source for most plant-based eaters. More research is needed to study the long-term effects of the Paleo diet.

GLUTEN-FREE

Gluten is a mix of proteins found in grains like wheat, rye, and barley. It gives elasticity to dough made from these grains. In individuals with **celiac disease**, gluten triggers an immune response that damages the lining of the small intestines. This causes discomfort and disrupts nutrient absorption. Ultimately, it can lead to serious health conditions, including depression, infertility, headaches, skin rashes, seizures, and neuropathy. Some people are sensitive to gluten but have less severe reactions.

A gluten-free diet includes

- fish, poultry, and meat;
- dairy without added ingredients;
- gluten-free grains like quinoa, rice, and oats;
- starches like potatoes, corn, almond flour, and corn flour;
- nuts and seeds;
- vegetable oils and butter;
- eggs; and
- fruits and vegetables.

GLUTEN:

A mixture of proteins that is found in wheat, rye, and barley and gives dough its elastic texture.

CELIAC DISEASE:

An autoimmune disorder that affects the small intestines and that is caused by gluten in the diet.

Gluten-free adherents avoid anything with wheat, barley, or rye. This includes ingredients and foods like malt, beer, and brewer's yeast. Candy, baked goods, popcorn, pretzels, chips, crackers, and many condiment sauces like soy sauce and teriyaki sauce include gluten or gluten-based ingredients.

Avoiding gluten isn't necessary for anyone without a gluten allergy or celiac disease, but many healthy people choose this diet. Cutting out wheat and other grains is essentially a low-carbohydrate approach, which can lead to weight loss. Depending on the foods actually eaten, a gluten-free diet may lead to improved cholesterol levels, better digestive health, and the elimination of many processed foods from the diet.

Without guidance or balanced, healthy food choices, a gluten-free diet may actually increase calorie intake. Many processed gluten-free foods include added sugar and calories to replace the grains removed. Studies have also shown that a gluten-free diet can cause constipation or diarrhea. To go gluten-free healthfully, individuals should reach for naturally gluten-free foods: vegetables, fruits, fresh meat, fish, dairy products, and poultry.

Another concern critics have about any diet that cuts out gluten is that wheat products are often fortified with micronutrients like vitamin B and iron. There is a risk of deficiencies on this diet.

DID YOU KNOW

A gluten-free menu is becoming more common in many restaurants based on growing demand? Most major food chains in the United States offer gluten-free ingredients that can be substituted, and many have a full gluten-free menu. It is getting easier for those who truly need it to stick with a gluten-free diet.

When gluten-free options are not available, the enzyme dipeptidyl peptidase-IV (DPP-IV) is available in over-the-counter pills. It breaks down gluten proteins and reduces the symptoms of gluten intolerance when taken before eating.

FASTING:

Abstaining from consuming food for a period of time.

INTERMITTENT FASTING

Intermittent **fasting** is a type of diet that focuses on timing of food intake in a 24-hour period or weekly rather than on specific types of food. There are two popular variations of the fasting diet: 5/2 and 16/8.

The 5/2 Diet

The 5/2 fasting diet involves eating a normal, balanced, and healthy diet five days a week and fasting for two days. The fasting days are not strictly days with no food. The idea is to consume 25 percent—or even less—of a normal day's calories.

With 2,000 calories for a normal day, this means eating just 500 calories or less on fasted days. The fasted days should not be consecutive, and this eating plan does not restrict types of food. The simplicity of the diet makes it easy for most people to maintain. Over the course of a week, it is possible to reduce calorie intake by about 3,000 calories, or one pound of body fat.

The 16/8 Diet

The 16/8 method involves abstaining from food entirely for 16 consecutive hours per day and eating only during an eight-hour window each day. The eight hours should align with the most active hours of the day to avoid fatigue.

Figure 17.2 16/8 Fasting



For example, for an adult who gets up at 7:00 a.m., works from 9:00 to 5:00, works out at 6:00 and goes to bed at 11:00, a good time for the eight-hour eating window is between 10:00 in the morning and 6:00 in the evening. There are no food requirements, but as with the 5/2 plan, the diet should be balanced and healthful.

Both of these popular versions of intermittent fasting work by reducing the overall calories consumed and encouraging healthy eating habits. This type of dieting works best for those clients who are able to eat a normal or recommended amount of calories most of the time. Studies have shown that fasting not only helps people consume fewer calories but also leads to moderate weight loss, less muscle wasting, decreased serum leptin and blood levels of triglycerides, and increased LDL cholesterol.

Intermittent fasting isn't for everyone. For some clients, it may be too difficult to restrict calories during fasting periods or to avoid food entirely for 16 hours. The struggle can lead to an unhealthy relationship with food and eating and even binge eating. For those who are able to abstain with minimal side effects or distress, intermittent fasting can have positive benefits.

CARB CYCLING

Carb cycling is another dietary approach that focuses on timing. It involves making targeted reductions and increases to carb intake on a daily, weekly, or monthly basis.

This style of diet is often used by fitness and bodybuilding competitors. It may also appeal to people trying to lose fat, bust a weight loss plateau, or maintain a high level of physical performance while dieting. The frequency and duration of cycling carbohydrates depends on activity level. In general, carb intake is reduced or cut during low-activity periods and increased during performance and high-activity periods.

There are several situations in which carb cycling can be useful. It's possible to drop carbs for a period of time, for instance, to reach a desired body fat percentage. From there, carbs are slowly reintroduced. Bodybuilders and figure competitors use this strategy. Endurance and strength athletes often increase carb intake ahead of a competition or race to ensure adequate and even excess glycogen stores.

For general fitness enthusiasts, an easy way to carb cycle is to keep to a lower carb diet during the work week and increase carbs on off days. Athletes will cycle according to training and activities, adding more carbs on heavy workout days and less on low-intensity or rest days.

CARB CYCLING:

increasing and reducing carb intake on a daily, weekly, or monthly basis.

REFEED:

Reintroducing carbohydrates into the diet after an extended reduction of a week or more.

When carbs are added back into the diet after an extended phase of dieting (for example, a week or longer), this is called a **refeed**. This decreases the hormone leptin to help reduce the feelings of hunger and boost the resting metabolic rate, which can be downregulated with prolonged low-calorie intake.

There are few good studies on carb cycling because it is a style of eating with a lot of individual variety. However, research on low carbohydrate intake suggests it may improve insulin sensitivity and promote the use of fat as fuel.

Much of the feedback on carb cycling is based on personal experiences and anecdotal evidence. Risks of carb cycling are similar to those for low-carbohydrate diets during the periods of low or minimal intake. The refeed period may turn into an unhealthy binge.

Myths and Facts about Diets

Myths about diets and dieting abound. Part of the job of a nutrition coach is to help clients navigate these myths and learn the truth.

MYTH: Eating after 7:00 at night leads to weight gain.

TRUTH: Late night eaters often gain weight not because of timing but from their food choices. Eating from boredom can cause people to reach for unhealthy, calorie-dense foods like potato chips, cookies, and candy. It's better to avoid these snacks and reach for something healthier, like fresh vegetables or yogurt. It is also important to recognize that most people are not active at night. Their time awake is spent reading, sitting, or watching television. The body has no actual demand for calories late at night. Often, the sensation of being thirsty is mistaken for hunger, so the best defense to late night snacking is a glass of water.

MYTH: Skipping breakfast leads to weight gain.

TRUTH: There is no proof that skipping breakfast causes weight gain. Eating early is especially important for anyone who works out first thing in the morning. There is also some evidence that people who eat earlier in the day are better able to manage hunger later and make healthier food choices as a result. Most of all, it is important to listen to the body, to eat when hungry, and to stop when full.

MYTH: Cutting back on carbohydrates is a fast way to drop weight.

TRUTH: Simple, processed carbohydrates are low in nutrients and should be minimized in a healthy diet. However, complex carbs, like whole grains, fruits, and legumes, are good sources of carbohydrates that also provide nutrients and the energy needed to be active.

MYTH: Low-fat and fat-free foods are best.

TRUTH: Foods with fats removed from them often have fillers, chemicals, and added sugars in their place. They are often more calorie dense than their full-fat counterparts. Instead of reaching for a reduced-fat food, focus on healthy fats in moderation.

MYTH: Reduce sodium intake by switching to sea salt.

TRUTH: Salt is salt, no matter the form. The difference is that sea salt crystals are larger and contain less sodium per weight unit than table salt. Also, table salt is typically infused with iodine—a crucial trace element necessary for proper thyroid function. Without salt or a multivitamin supplement, most people will not get enough iodine in their diet. Moderation is always important with any form of sodium.

MYTH: Drinking more water every day helps shed pounds.

TRUTH: There is no real evidence that more water has any effect on metabolism or fat burning. Water is required for nearly every process in the body, so drinking an adequate amount is important. Excess water provides no benefits, though, as it is simply excreted.

NAVIGATING A SUCCESSFUL DIET

When someone goes on a diet to lose weight, it is important to consider what is actually causing weight loss. Several factors may be involved in short-term weight loss that are not always sustainable, including food volume, calorie intake, and water loss.

The body is physically unable to reduce body fat by three or more pounds in a matter of a few days. It is important for nutrition coaches to recognize that a client's significant weight loss in a short period of time probably involves other internal processes, not just fat loss.

Short-term weight loss is overwhelmingly triggered by water loss. Carbohydrates and sodium cause the body to retain water. For every gram of carbohydrates that are stored as glycogen

in the body, two to three grams of water are also stored. An increase in sodium intake also leads to water retention. Additionally, sodium affects hormones like antidiuretic hormone (ADH) to reduce fluid intake as well.

With rapid weight loss, the opposite processes occur. Low carbohydrate intake reduces the body's stored water while a lack of sodium affects the ADH hormone to trigger more water consumption for fluid balance. Resulting water loss accounts for early weight loss on most diets.

Long-term weight loss, on the other hand, is based on consuming fewer calories than the body expends. Over time, a calorie deficit causes the body to metabolize fat, and in some cases muscle tissue, to supply the body with the energy needed for daily activity.

Good nutrition and a calorie deficit are not interchangeable. The quality of food in a diet must remain a priority. Ideal amounts of macronutrients, minerals, vitamins, and other micronutrients are essential for optimal health.

PHYSIOLOGICAL EFFECTS OF YO-YO AND EXTREME DIETING

A sound, effective diet for weight maintenance and health is a lifestyle adjustment that requires consistency. Clients looking for quick or dramatic results may resort to extreme eating styles. Fad diets, excessive supplementation, and severe calorie restriction can cause both psychological and physiological harm.



Known as **weight cycling**, repeatedly losing and regaining weight disrupts the body's basal metabolic rate (BMR), fuel use, and increased fat cell storage (due to metabolic changes). It also typically leads to weight regain. In other words, the rapid weight gain someone sees after the cessation of a diet, typically beyond where they were when starting the diet, is the body's response to the stress of the extreme diet.

WEIGHT CYCLING:

Repeated weight loss and gain, also known as yo-yo dieting.

Studies have shown that inflammation can also rise dramatically as a result of extreme, repeated dieting cycles. Inflammation is one of the leading causes of chronic diseases like heart disease, cancers, and autoimmune disorders like arthritis and lupus.

MINDFUL EATING

Mindful, or intuitive, eating involves listening for and responding to the body's natural cues for thirst, hunger, and satiety. Many people live busy, stressful lives that make mindful eating difficult. Modern lifestyles generally encourage mindless, excessive, and unhealthy eating patterns.

Food and eating are deeply rooted in human social culture and are linked to emotions. Celebration, joy, anger, anxiety, and sadness are some of the emotions that can trigger mindless eating that mask the mental health issues that need to be addressed in more productive ways.

Studies that placed an emphasis on being fully engaged when selecting, preparing, and eating food showed that mindfulness reduced overall intake and aided in weight loss and weight maintenance. These benefits were seen even without calorie counting or strict dieting.

Figure 17.3 The Hunger Scale



Intuitive eating focuses on the scale of “hungry,” “neutral,” and “satisfied.”

Registered dietitians Evelyn Tribole and Elyse Resch are the authors of *Intuitive Eating: A Revolutionary Program That Works*. They encourage mindful eating for general health, as part of treatment for eating disorders and for weight loss or maintenance. With mindfulness and management of emotions and reactions, food stops acting as an outlet or a reward. It simply becomes fuel for living. This is the ultimate goal of any healthy eating pattern.

THE MOST EFFECTIVE DIETS

There is no perfect diet that works for everyone. But there are a couple of diets, or eating styles, as well as guidelines that provide the most effective, safe, and sustainable ways to maintain a healthy weight and good overall health.

The US Department of Agriculture and the Department of Health and Human Services have created guidelines and tools to help create a lasting, healthy diet. Two specific types of diet, the DASH diet and the Mediterranean diet, are recommended and approved by the ADA and the WHO for their sustainability and balanced approach.

THE DIETARY GUIDELINES FOR AMERICANS (DGA) AND MYPLATE

The Dietary Guidelines for Americans provide a resource for navigating healthful eating habits and are backed by nutritional science. According to the DGA, a healthy eating pattern includes

- focusing on a lifetime of healthy eating;
- choosing a variety of foods and focusing on nutrient density and amount;
- limiting added sugars, saturated fats, and sodium;
- choosing more healthy foods and beverages; and
- focusing on whole foods like fruits, vegetables, whole grains, and high-quality protein.

While there is no perfect dietary style, these general guidelines promote balance and moderation to create an eating style that prevents chronic and preventable diseases while encouraging a healthy weight.

MyPlate was developed in response to the obesity crisis in America. It is a simplified eating pattern that replaces the former food pyramid. It helps consumers follow the DGA by providing an easy graphic in the form of a plate of food. MyPlate represents fruits, grains, proteins, dairy, and vegetables in their appropriate proportions.

THE DASH DIET

DASH stands for Dietary Approaches to Stop Hypertension. It was developed based on research conducted by the National Institutes of Health. The primary audience for the DASH diet is anyone with high blood pressure, with the goal of reducing hypertension with fewer or no medications. The diet is simple. There are no special food restrictions, just a weekly plan of a healthy 2,000 calories per day. The diet focuses on low-fat dairy, fish, poultry, beans, nuts, and vegetable oils while avoiding fatty meats, full-fat dairy, coconut and palm oil, and sweets. The DASH diet can be followed with a normal sodium intake of up to 2,300 milligrams daily or with reduced sodium intake of up to 1,500 milligrams daily.

Table 17.2 Daily and Weekly DASH Eating Plan Goals for a 2,000-Calorie-a-Day Diet

FOOD GROUP	DAILY SERVINGS
Grains	6–8
Meats, poultry, and fish	6 or less
Vegetables	4–5
Fruit	4–5
Low-fat or fat-free dairy products	2–3
Fats and oils	2–3
Sodium	2,300 mg
FOOD GROUP	WEEKLY SERVINGS
Nuts, seeds, dry beans, and peas	4–5
Sweets	5 or less

The DASH diet recommends that 55 percent of daily calories come from carbohydrates, approximately 27 percent from unsaturated fats, 6 percent from saturated fats, and 18 percent from protein.

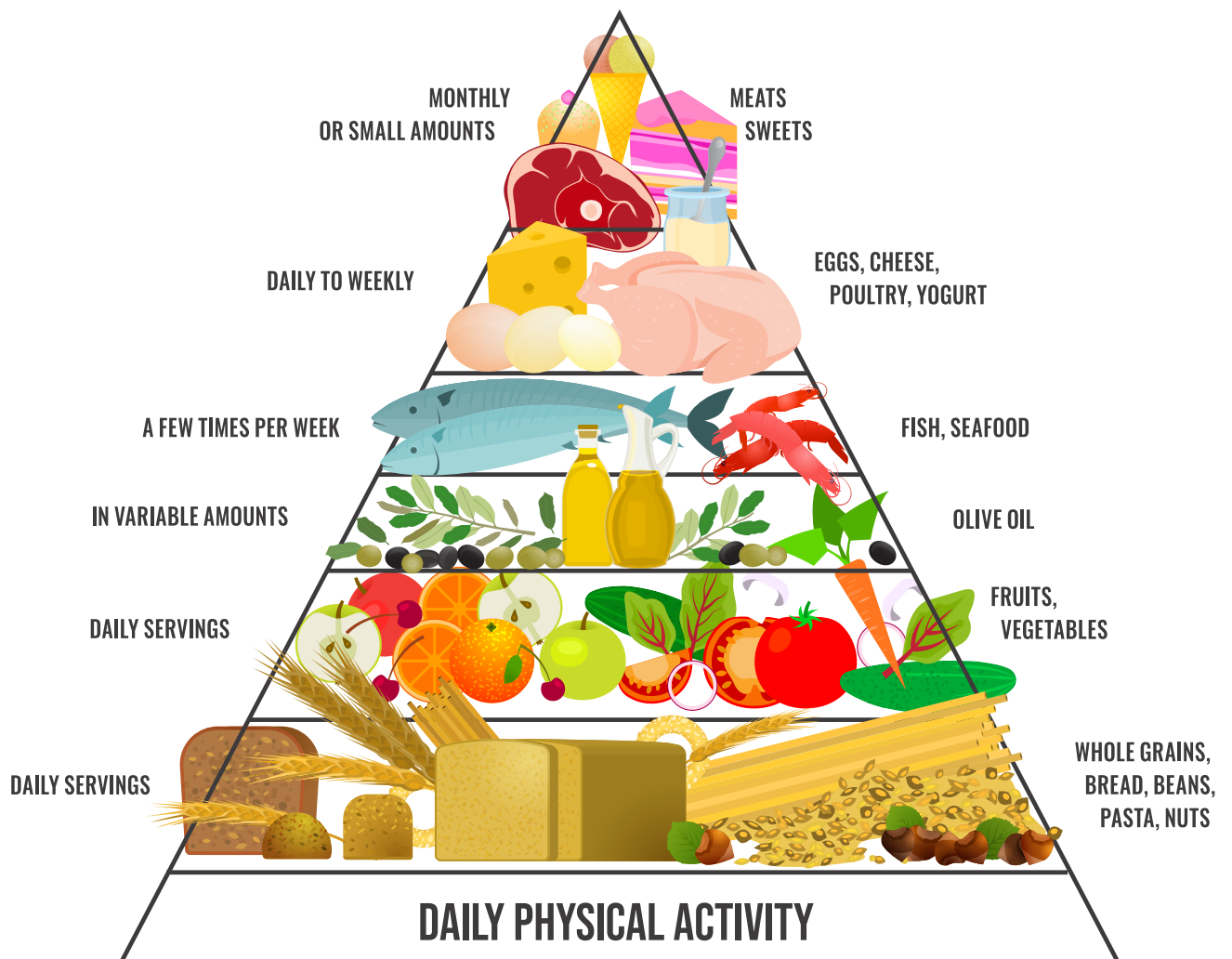
Tips include filling the plate with colorful, whole foods and including two or more servings of fruits and vegetables per meal, with a particular emphasis on dark, leafy green vegetables. In addition to lowering blood pressure, the DASH diet has other health benefits: prevention of bone loss, improved cardiovascular health, and weight loss or maintenance.

MEDITERRANEAN DIET

Global health and wellness research has shown that people who live in several Mediterranean countries, including Greece, Spain, and Italy, have lower rates of chronic health issues. This is widely attributed to the typical diet of the region.

The benefits of the Mediterranean diet are so widely recognized and accepted that the WHO and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) have added the diet to its list of intangible cultural heritages. The listing aims to protect the “skills, harvesting, cooking, and consumption of food” that the diet promotes.

Figure 17.4 The Mediterranean Diet



DID YOU KNOW

That the Mediterranean Diet is based on the actual, observed eating patterns of the general population of Mediterranean countries like Spain, France, Greece, and Italy? Residents in these countries eat nutritious, balanced diets of healthy fats, whole grains, fruits, vegetables, and lean meats. The focus, as in many European countries, is on fresh foods rather than processed foods. Researchers and nutrition experts observed more stable and healthy body weights, well-controlled blood sugar, and reduced risk of cardiovascular disease in the people of this region and have attributed these almost completely to regular eating patterns.

The Mediterranean diet consists of moderate portions of fruits, vegetables, whole grains, legumes, potatoes, nuts, seeds, olive oil, fish, poultry, dairy, and eggs, with minimal red meats. Olive oil, nuts, and seafood are eaten regularly in this diet. The high levels of heart-healthy omega-3 fatty acids in them may be a major reason that chronic disease and cardiovascular risks are lower in the Mediterranean population. The diet is often recommended to people who have a high risk of heart attack, arterial plaques, and stroke.

**Table 17.3 Daily and Weekly Mediterranean Eating Plan Goals
for a 2,000-Calorie-a-Day Diet**

FOOD GROUP	DAILY SERVINGS	FOOD GROUP	WEEKLY SERVINGS
Grains	5–6	Red wine (allowed, but not required)	1–4
Leafy greens	1–2	Potatoes	1 or less
Vegetables	3–4	Meats, poultry, and fish	1 or less
Fruit	3–4	Dairy	In moderation
Nuts	1–2		
Olive and canola oils	2–3		
Added sodium (140 mg per serving or less)	3–8		

The fresh, light foods that make up this diet are filling and satisfying. Over time, this naturally leads to a decrease in calorie intake and helps promote weight loss. Studies have shown that the Mediterranean diet can reduce cardiovascular disease risk up to 30 percent and trigger a significant reduction in the risk of developing type 2 diabetes.

Questions a Nutrition Coach Should Consider When Recommending a Diet

With so many eating patterns and diets available, a nutrition coach must determine which one will most benefit the client. The “best” plan will be based on the client’s goals, timelines, and current and desired physical condition.

Here are some questions a coach should consider when deciding what to recommend:

- Will this approach lead to better results (fat loss, muscle gain, blood pressure reduction, and so on)?
- Will this approach support the client’s daily activity levels?
- Is this approach likely to lead to nutrient deficiencies?
- Will this approach be balanced?
- Is this approach realistic and sustainable for the client over the long term?

If the overall answer to these questions is yes, there is a good chance the recommendation will constitute an effective and sustainable eating pattern. If the answer is overwhelmingly no, further consideration of the options is necessary to make the most effective recommendation.









CHAPTER 18

SPECIAL NUTRITION SCENARIOS

LEARNING OBJECTIVES

- 1 | Identify and define special nutrition scenarios.
- 2 | Define common key terms related to common nutrition scenarios.
- 3 | Identify which scenarios are outside the scope of practice and require a professional referral.
- 4 | Provide talking points to use when discussing special scenarios with affected clients.

BEYOND THE SCOPE OF PRACTICE

Local laws and governing bodies will determine the scope of practice for certified nutritionists. Generally, a nutrition coach may not practice medical nutrition therapy pertaining to health conditions such as diabetes, disordered eating, alcoholism, morbid obesity, and other serious or chronic conditions. However, as part of an overall health care team, the nutrition coach should be aware of the special nutrition scenarios they may encounter with clients, the nutritional effects of these situations, and the various interventions used to treat chronic conditions.

DIABETES MANAGEMENT

The vast majority—over 75 percent—of adults with diabetes are overweight or obese. Nutrition interventions have proven successful, yet many individuals don't know that dietary counseling is an option. One study found that only about 9 percent of adults diagnosed with diabetes have seen a registered dietitian in the past nine years of their illness.

If a client reports being diagnosed with diabetes, a nutrition coach should encourage them to schedule a visit with a registered dietitian for dietary suggestions. Many of the guidelines for a diabetic individual will be similar to those for the general population, so a nutrition coach would be fully prepared to work with them. However, a registered dietitian can provide advice for specific considerations that the coach can then help the client implement.

Common Dietary Interventions

There is no single, scientifically backed dietary plan that works for everyone with diabetes. The same general nutrition guidelines apply to a diabetic client as to a general client; overall calorie intake, variety of foods, balance, and consistency remain the focus. Physical exercise is always a beneficial addition to a healthy, maintainable lifestyle.

However, several eating patterns have been shown to be somewhat effective in managing diabetes. These include the Mediterranean-style eating plan, the Dietary Approaches to Stop Hypertension (DASH) eating plan, a plant-based diet, a lower-fat diet, and lower-carbohydrate diets. There are many foods that do not affect blood glucose levels as much, and these are known as low-glycemic foods. They are more slowly digested, absorbed, and metabolized and therefore cause a slower blood glucose rise. Diabetic clients can focus on these low-glycemic food options as well.

Here are the goals of nutrition interventions for diabetes:

- Promote and support healthful eating patterns.
- Emphasize variety and nutrient density.
- Teach proper portion sizes.
- Achieve and maintain healthy bodyweight.
- Delay or prevent complications from diabetes.

Other elements of diabetes counseling include the following:

- Weekly self-weighing
- Daily breakfast to control blood sugar
- Reducing fast-food consumption
- Meal replacement foods or supplements to reduce calorie intake

These goals and elements are aimed at improving the client's individual glycemic, blood pressure, and blood lipid goals. Blood glucose levels are measured by an **A1C** test and reported as a percentage. For most adults, their A1C should be less than 7 percent. A healthy blood pressure should be less than 120/80 millimeters of mercury. Finally, blood lipids should maintain the following levels:

- LDL <100 milligrams per deciliter (mg/dL)
- Triglycerides <150 mg/dL
- HDL (men) >40 mg/dL
- HDL (women) >50 mg/dL

Blood glucose, lipids, blood pressure, weight, and renal function levels must be monitored on a regular basis by a diabetic client's physician.

DISORDERED EATING

Disordered eating and **eating disorders** are very different conditions. Both involve an abnormal relationship with food, and only diagnosis by a qualified professional can determine the difference. Any irregular eating behavior—binge eating, purging, starvation, self-denial, obsession, and so on—is considered disordered eating. However, for someone to be diagnosed with an eating disorder, their symptoms must fall into specific criteria as determined by the American Psychiatric Association.

A1C:

A type of hemoglobin, commonly abbreviated as HbA1c, bound to glucose and commonly used as a marker to reflect how well type 1 and type 2 diabetes are controlled.

DISORDERED EATING:

Unhealthy eating behaviors and feelings about body image.

EATING DISORDERS:

Abnormal or disturbed eating habits (once diagnosed) such as anorexia or binge eating..

Common Types of Disordered Eating

Anorexia nervosa is an emotional eating disorder in which a person obsesses over losing weight and restricts caloric intake in a dangerously extreme fashion. Only about half the patients with this condition will make a full recovery with proper treatment.

Another common emotional eating disorder is bulimia nervosa. Individuals suffering from bulimia often have a distorted body image and engage in extreme overeating (binging), followed by depression and self-induced vomiting (purging) or fasting. With treatment, about half of bulimia sufferers can recover.

Binge-eating disorder is considered a severe, life-threatening eating pattern in which the individual regularly overconsumes calories. Unlike bulimia, binge eaters do not typically purge after consumption, and the result of such high-calorie intake is weight gain. This is the most common eating disorder, with about 2 percent of people worldwide being affected. It also has the best treatment outcomes, with about 70 percent of patients recovering with the proper guidance and support.

Other Disordered Eating Habits

- **Orthorexia:** The name originates from the word ortho, meaning “correctness.” Orthorexia is an unhealthy preoccupation with “eating healthy” or “eating properly.” People with this condition will restrict based on “good” and “bad” foods and may feel guilt or anxiety surrounding the “wrong” foods.
- **Cognitive dietary restraint:** Someone who constantly is thinking about food, dieting, or restricting may have cognitive dietary restraint. They may never act on their feelings about food, but the mere thoughts have the power to create a physical, stress, or hormonal response.
- **Body dysmorphia:** This is a mental disorder in which someone is extremely preoccupied with flaws in their appearance, whether imagined or real. They may think themselves imperfect or in need of changes, even if their body is healthy and falls within “normal” ranges for their age and height.
- **Food addiction:** When the need to eat or consume calories becomes compulsive or unpredictable, this is food addiction. Someone with food addiction no longer uses food as fuel for their body but as a response to emotion or stress or as a coping mechanism. Long-term food addiction can disrupt the body’s natural hunger signals and hormones, leading to eating despite being full and seemingly uncontrollable and frequent food cravings.

Signs and Symptoms

If a coach observes any of the following signs or symptoms in combination, a referral to a registered dietitian might be in order.

Table 18.1 Symptoms and Signs of Eating Disorders

	ANOREXIA NERVOSA	BULIMIA NERVOSA
Physical	Dehydration Dizziness Fainting Fatigue Low blood sugar Low body temperature Underweight or extreme thinness Bruising Dry hair Headaches Slow heart rate	Dehydration Fatigue Dizziness Muscle cramps (caused by electrolyte imbalance) Bad breath Dental cavities Weight changes Sore throat Use of the restroom immediately after eating Stomachaches
Emotional	Depression Compulsive behavior Social isolation Uncomfortable around food Anxiety	Compulsive behavior Anxiety Guilt Mood swings Depression Poor self-esteem

Dos and Don'ts for a Nutrition Coach

A fitness and nutrition professional must listen to their clients. The physical signs of disordered eating may exist in many clients, but the psychological and emotional symptoms may be harder to notice. If a coach suspects a client of disordered eating, here are some dos and don'ts.

A coach should DO the following:

Listen to and hear what their client is saying about how they feel.

Have a network of medical professionals to whom they can refer clients.

Encourage clients to seek help as soon as possible.

Ensure that they are providing accurate information and recommendations about nutritional guidelines and sustainable lifestyles.

Encourage positive self-image in their clients.

Be sensitive and discreet.

Comply with any treatment plans if their client is under the care of a medical or psychological professional.

A coach should NOT DO any of the following:

Make derogatory remarks about a client's weight or appearance

Focus on weight or measurements too frequently

Judge or criticize

Provide "simple" solutions ("All a person has to do is...")

DID YOU KNOW

That a short five-question client survey can help a coach identify someone's risk of disordered eating? The SCOFF questionnaire asks the following questions:

- 1 Do you make yourself sick because you feel uncomfortably full?
- 2 Do you worry you have lost control over how much you eat?
- 3 Have you recently lost more than one stone (14 pounds) in a three-month period?
- 4 Do you believe yourself to be fat when others say you are too thin?
- 5 Would you say food dominates your life?

If a client answers yes to two or more of these questions, a coach should strongly consider making a referral to a specialist.

Outside of changes in weight, disordered eating carries many potentially adverse health effects. Conditions like anemia, nutrient deficiencies, permanent electrolyte imbalance, kidney issues, dry skin, chronic edema (swelling), and problems regulating body temperature can occur. Many of these conditions cannot be remedied.

ALCOHOL-USE DISORDER

There are no globally recognized alcohol consumption recommendations, but the Center for Disease Control and Prevention (CDC) recommends moderation, which they define as up to one drink per day for women and up to two drinks per day for men. One drink is equal to 14 grams of alcohol or 12 ounces of beer, 8 ounces of malt liquor, or 5 ounces of wine.

Estimates suggest that more than 15 million people in the United States struggle with some sort of alcohol-use (or, more the point, overuse) disorder.

Signs and Symptoms

Acute physical symptoms of alcohol use include slowed reaction time, blackout, trouble with motor control, impaired judgement, increased risk-taking, memory impairment, memory lapses, and slurred speech. Anyone showing these signs likely still has alcohol in their blood.

The chronic physical symptoms of prolonged and excessive alcohol consumption include signs of malnutrition, restlessness, agitation, anxiety, muscle tremors, nausea and vomiting, and cardiovascular disease.

Behavioral symptoms include frequent binge drinking, moodiness, declining work performance, making excuses for neglecting responsibilities, acts of violence, decreased interest in activities outside of drinking, and denial of excessive alcohol use.



Interventions for Alcohol-Use Disorder

The first step in treating an alcohol-use disorder is the initial detoxification, or detox. The detox period must be medically supervised so that withdrawal symptoms can be monitored and treated. Inpatient rehabilitation may be necessary in many cases. This is the most structured type of treatment and can last 30, 60, or 90 days. Around-the-clock care is given.

Following successful inpatient treatment, alcohol counseling and support is necessary. Clients should meet with an alcohol counselor to address triggers—peers, family relationships, work, or other circumstances. The counselor may also teach clients how to manage emotions, offer health education, or both.

To find local services in the United States for clients with an alcohol-use disorder, a coach can look to the Substance Abuse and Mental Health Services Administration. This government-funded organization provides information resources and acts as a referral service.

Research has shown how nutrition can be used to reduce hypoglycemic symptoms, decrease sugar and alcohol cravings, and increase nutrient intake during alcohol rehabilitation. When working with a recovering client, a coach should adhere to any protocols and recommendations provided by the client's health professional.

MORBID OBESITY

A person who is morbidly obese has an excessive amount of bodyfat. They typically have a body mass index (frequently written as BMI) of 35 or higher.

Signs and Symptoms

Clients who are morbidly obese typically experience a variety of health problems. Along with coping with fatigue, joint pain, trouble walking, or trouble breathing, morbidly obese clients are at a much greater risk of developing chronic diseases.



Common Dietary Interventions

The most common intervention for treating morbid obesity is a very low-calorie diet (LCD). Calories are restricted to between 450 and 800 kilocalories per day. Clients selected for this type of intervention often lose a significant amount of weight in just 8 to 16 weeks. LCDs, in which daily calories are reduced by 25 to 30 percent, are also used to reduce obesity. Registered dietitians make personalized recommendations for LCDs based on the client's energy requirements, the severity of obesity, and other diseases for which the client is being treated.

Intermittent fasting may serve as an additional or complementary intervention. Recent trials have shown how pairing LCDs with intermittent fasting improves body composition—lowering fat mass—and metabolic parameters. The trial was successful for patients with obesity, including those with type 2 diabetes.

HEALTH MANAGEMENT

The health conditions previously discussed are outside the scope of practice for a nutrition coach because of the level of care, individual variability, management, and expertise required. The following health conditions have been successfully treated with dietary interventions. The methods for controlling or preventing hypertension, osteoporosis, and heart disease are well researched and proven.

The nutrition coach may not practice medical nutritional therapy by creating personalized meal plans. However, they may share the following recommendations.

HYPERTENSION

Blood pressure is the pressure of circulating blood on the walls of the blood vessels. It is measured in terms of systolic and diastolic pressure. Systolic pressure (the top number in a reading) is the pressure of blood as it leaves the heart while diastolic pressure is the measure of blood in between heart beats. Normal blood pressure ranges between 90 and 120 systolic and 60 and 80 for diastolic. **Hypertension** is a condition of abnormally high blood pressure, usually over 130/80. The CDC estimates that one in three adults over the age of 20 in the United States have hypertension or are prehypertensive.

Dietary Approaches to Stop Hypertension (DASH) is a flexible and balanced eating pattern specifically addressing this common condition. For clients managing hypertension, the key is the reduction of daily sodium intake.

HYPERTENSION:

A condition of abnormally high blood pressure, usually over 130/80.

The DASH diet guidelines encourage individuals to eat the following foods:

- Vegetables
- Fruits
- Whole grains
- Fat-free or low-fat dairy
- Fish
- Poultry
- Beans
- Nuts
- Vegetable oils

Foods high in saturated or trans fats should be limited. Intake of added sugars (those found in sugar-sweetened beverages and sweets) and alcohol should be reduced from the daily maximum recommendation referred to earlier. Additional recommendations include choosing foods rich in calcium, fiber, magnesium, potassium, and protein.

OSTEOPOROSIS

Human bones are at their densest around the age of 30. Cells within bones are constantly remodeling and repairing while regulating calcium in the body.

Osteoporosis is a bone condition in which bones become weak and brittle. Logic suggests that increasing the daily intake of bone-strengthening calcium would prevent osteoporosis. However, data from the Food and Agriculture Organization / World Health Organization does not support this. Women over 50 are the most susceptible to osteoporosis, and the condition is four times more common in women than in men.

The precursor to osteoporosis is osteopenia. This occurs when the body is unable to make new bone as quickly as it absorbs or breaks down old bone. Osteopenia is common in the United States and is caused in part by a low-calcium diet as well as by smoking, hormones, and some medications (similar to full osteoporosis).

The leading cause of osteoporosis is a lack of estrogen in women and androgen in men. A sedentary lifestyle, thyroid conditions, smoking, some medicines, and nutrient deficiencies also play a part in the development of osteoporosis.

DID YOU KNOW

That physical exercise and strength training with weights put stress on the muscles and therefore the bones? The result of consistent resistance training is the thickening of muscle tissue and the increase in bone density. Keeping bones as strong as possible for as long as possible in the life span can combat the natural bone loss people face as they age. This is one of the many reasons seniors are encouraged to exercise and to work on flexibility.

Physical exercise puts stress on bones, which promotes bone fortification and strength. Diet is also important for taking in the required minerals and vitamins needed for bone development and growth. The prevention of osteoporosis requires a consistent lifestyle of exercise and sound nutrition. Clients with osteoporosis can prevent further damage and injury by increasing their intake of calcium via dietary adjustments and supplements if needed.

Table 18.2 Dietary Sources of Nutrients for Osteoporosis

FOOD	NUTRIENT
Dairy	
Low-fat and nonfat milk, yogurt, and cheese	Calcium
Fish	
Canned sardines and salmon (with bones)	Calcium
Fatty fish such as salmon, mackerel, tuna, and sardines	Vitamin D
Fruits and vegetables	
Collard greens, turnip greens, kale, okra, Chinese cabbage, dandelion greens, mustard greens, and broccoli	Calcium
Spinach, beet greens, okra, tomato products, artichokes, plantains, potatoes, sweet potatoes, collard greens, and raisins	Magnesium
Tomato products, raisins, potatoes, spinach, sweet potatoes, papaya, oranges, orange juice, bananas, plantains, and prunes	Potassium
Red peppers, green peppers, oranges, grapefruits, broccoli, strawberries, brussels sprouts, papaya, and pineapple	Vitamin C
Dark leafy greens such as kale, collard greens, spinach, mustard greens, turnip greens, and brussels sprouts	Vitamin K
Fortified foods	
Certain juices, breakfast foods, soy milk, rice milk, cereals, snacks, and breads	Calcium and vitamin D

HEART DISEASE

The phrase heart disease can describe any number of conditions affecting the blood vessels, heart, and blood and is the number one cause of death in the United States. One of the most common forms of heart disease is atherosclerosis, which is caused by the buildup of cholesterol on the walls of arteries.

The best treatment for heart disease is prevention. The American Heart Association suggests the following diet and lifestyle habits:

- People should aim to burn at least as many calories as they consume daily.
- Each week, people should get 150 minutes of moderate physical activity or 75 minutes of vigorous activity, or a combination of the two.
- People should eat a variety of foods from each of the food groups.
- People should eat fewer calorie-dense, nutrient-poor foods.

The DASH eating pattern, so helpful for hypertension, has also proven to be effective at preventing heart disease and is an option for at-risk clients.

If a client has a heart condition, a coach should hold them accountable for regular visits with their physician to monitor blood pressure and lipids. It's important for a nutrition coach to not prescribe a meal plan or to counsel clients on specific dietary needs.

DID YOU KNOW

How important it is for clients to take an active role in their health to prevent heart disease? The more they understand their risks and current health, the better able they will be to prevent heart disease. A coach should encourage their clients to ask questions.

Here are some questions clients can ask their doctors to better understand their heart health and risks:

- What is my personal risk of heart disease?
- What is my blood pressure, and what does it mean?
- What are my cholesterol levels?
- Are there activities I need to avoid?
- What tests are you doing for my heart?

LIFE SPAN CONSIDERATIONS

When considering the entire life span, a coach must consider the needs of young people from infancy through the teenage years, the specific needs of women during pregnancy and while nursing, and how nutritional needs change in late adulthood and senescence.

YOUTH

Nutritional habits and good health begin in infancy. Breastfeeding is considered the ideal option to support optimal infant growth and development. Outcomes improve if breastfeeding lasts for 12 months or longer. If new moms cannot breastfeed, as discussed later, there are other options more readily available. Infant formulas are now available to provide the necessary nutrients to growing babies.

Infants and young children can usually self-regulate calorie intake innately. They may eat very small amounts at one meal and very large amounts at another. But at a young age, children are eating for sustenance, not as a response to emotions. This is a learned behavior they adopt as they age. Around six months of age, infants will typically begin to transition to solid foods in addition to breastfeeding. Fresh, whole foods can be pureed or cooked for ease of consumption and minimal chewing, as most babies begin to break teeth around the same age. Premade baby food is readily available in stores, but some parents choose to prepare fresh options at home. Infant taste buds develop slowly, but research does not support the idea that babies should not have stronger-tasting foods. Parents can introduce new, solid foods one at a time into the baby's diet to see how they respond. The slow introduction of new foods will prevent gastric upset and protect against as-yet-unidentified food allergies.

As children enter their early teens, they start puberty. The dramatic hormone shifts, growth spurts, and brain changes occurring during puberty lead to an increased need for nutrients and calories to support the growth. Females in puberty typically require around 2,000 calories daily while pubescent males can require 2,500 to 3,000 calories daily. The focus should be on whole foods, iron, zinc, vitamins, and fiber to support efficient growth and brain maturation.

DID YOU KNOW

That childhood obesity is officially an epidemic? Obesity in children is defined as a child being overweight for their age and height. About 13.7 million children and teenagers are affected in the United States today.

Youth nutrition programs aimed at educating children and their guardians on proper nutrition and sustainable eating patterns are the key to successfully addressing and reversing this epidemic. Children who make good food choices typically grow into adults who continue to make good nutritional choices. The USDA's MyPlate and its associated resources are great tools to help children understand good food choices. These resources also provide useful information for adults who purchase the foods they then feed to their children.

Hydration for youth should not be overlooked. Children are smaller than adults, and for that reason, they can lose heat and water faster. Physicians typically recommend that youth between the ages of 2 and 9 drink 40 to 64 ounces of water daily and that youth ages 10 to 13 drink 64 to 80 ounces of water daily. Adolescents over 15 should be consuming a half gallon or more of water daily—the same intake as an adult. The recommendation for youth athletes is about twice these amounts to account for water loss during activity from perspiration and increased metabolism.

Malnutrition

When most people think of malnutrition, they think of starvation. It is much more than that. And malnutrition—deficiency, excess, or imbalance in a person's intake of energy and/or nutrients—is just as common in the developed world as in third-world countries. There are three types of malnutrition:

- 1 Undernutrition, including wasting (low weight for height), stunting (low height for age), and underweight (low weight for age)
- 2 Micronutrient-related malnutrition, including micronutrient deficiency or excess micronutrient intake
- 3 Overweight, obesity, and diet-related noncommunicable diseases, such as heart disease, stroke, diabetes, and some cancers

Malnutrition can be prevented with proper macronutrient and micronutrient intake in the form of a healthy diet. The following are suggested serving sizes for youth between the ages of 2 and 18.

Table 18.3 General Dietary Guidelines by Age and Gender (Youth and Teens)

AGES 2 TO 3: DAILY GUIDELINES FOR MALES AND FEMALES		
Calories*	1,000–1,400	
Protein	2–4 ounces	
Fruits	1–1.5 cups	
Vegetables	1–1.5 cups	
Grains	3–5 ounces	
Dairy	2 cups	
	AGES 4 TO 8: DAILY GUIDELINES FOR FEMALES	AGES 4 TO 8: DAILY GUIDELINES FOR MALES
Calories*	1,200–1,800	1,200–2,000
Protein	3–5 ounces	3–5.5 ounces
Fruits	1–1.5 cups	1–2 cups
Vegetables	1.5–2.5 cups	1.5–2.5 cups
Grains	4–6 ounces	4–6 ounces
Dairy	2.5 cups	2.5 cups
	AGES 9 TO 13: DAILY GUIDELINES FOR FEMALES	AGES 9 TO 13: DAILY GUIDELINES FOR MALES
Calories*	1,400–2,200	1,600–2,600
Protein	4–6 ounces	5–6.5 ounces
Fruits	1.5–2 cups	1.5–2 cups
Vegetables	1.5–3 cups	2–3.5 cups
Grains	5–7 ounces	5–9 ounces
Dairy	3 cups	3 cups

Table 18.3 General Dietary Guidelines by Age and Gender (Youth and Teens)
(Continued)

	AGES 14 TO 18: DAILY GUIDELINES FOR FEMALES	AGES 14 TO 18: DAILY GUIDELINES FOR MALES
Calories*	1,800–2,400	2,000–3,200
Protein	5–6.5 ounces	5.5–7 ounces
Fruits	1.5–2 cups	2–2.5 cups
Vegetables	2.5–3 cups	2.5–4 cups
Grains	6–8 ounces	6–10 ounces
Dairy	3 cups	3 cups
Adapted from the Mayo Clinic. *Calories depend on growth and activity level.		

Picky Eaters

Eating habits—whether healthy or not—are developed by age three. Therefore, this is a sensitive period of development. It is important to help children establish healthy eating habits for a lifetime of good nutrition. Here are some tips:

- Parents should be patient and consistently introduce healthy foods, even if children consistently refuse them.
- Parents should not push foods without overall nutritional value just to meet calorie needs.
- Parents should introduce a variety of colorful foods at each eating opportunity. At breakfast, parents might offer foods from three or more of the five major food groups. At the main meal, perhaps they could offer foods from four or more of the major food groups.
- Parents should introduce different textures by varying cooking methods—raw fruits and vegetables, cooked al dente, poached, steamed, mashed, boiled, broiled, baked, and so on.
- Parents should not use calorie-dense, sugar-sweetened foods as a bribe to get children to eat healthy food at mealtime.
- Parents should involve peer role models and show cautious children how other children enjoy new foods.
- Parents can invite children to be part of the process by letting them help select fresh foods in the grocery store and giving them age-appropriate chores in the kitchen during meal preparations.

PREGNANCY AND NURSING

Nutrition is an important part of pregnancy, as food not only fuels the mother but also helps the fetus grow and develop. Clients will have questions about what they should take to supplement their diet, support their fitness training, and keep their growing baby healthy.

Much of what women need to support a healthy pregnancy can be found in whole foods. However, with severe nausea and reduced stomach capacity (as the fetus grows), eating a balanced diet with a large variety of foods can be a challenge. Many physicians prescribe prenatal vitamins and may refer women to a registered dietitian to improve dietary intake. Here is some general nutrition advice to support a healthy pregnancy.



Weight Gain

The physician should closely monitor a woman's weight throughout her pregnancy. Depending on the mother's weight and physical condition prior to pregnancy, the average woman can expect to gain between 10 and 35 pounds during gestation. The Institute of Medicine recommends that a newly pregnant female not change her calorie intake during the first trimester. They should add 300 to 350 additional daily calories during the second trimester and 400 to 450 additional daily calories during the third trimester to support a growing fetus. Anything more will likely cause excess weight gain and potentially lead to health complications related to excess bodyweight like gestational diabetes or high blood pressure. These conditions can be dangerous for the mother and the baby.

Weight loss should not be a focus during pregnancy. If a client is losing weight during their pregnancy, they should see their physician immediately.

Nutrients

Pregnant women need vitamin D and calcium to help prevent **preeclampsia**. Inadequate calcium levels can trigger this dangerous condition, which leads to high blood pressure. And vitamin D is needed for proper absorption of calcium. Pregnant clients can get plenty of vitamin D by being out in the sun for 20 to 30 minutes three to four times a week. Fortified foods like milk, milk substitutes, almond milk, and cereals also provide vitamin D. Calcium can be found in fortified foods, leafy green vegetables, legumes, nuts, seeds, figs, and tofu. During pregnancy, women should consume about 1,000 milligrams of calcium per day and 600 international units (IU) of vitamin D.

PREECLAMPSIA:

A pregnancy condition of high blood pressure caused by inadequate calcium, typically beginning around 20 weeks. It can cause organ damage and be harmful to the growing fetus.

There are other minerals crucial during pregnancy:

- Zinc is important for cell division and protein synthesis. Women typically need twice as much iron during pregnancy (around 27 milligrams per day).
- Iron is essential for making red blood cells and carrying blood to the fetus.
- Vitamin B₁₂ helps promote cell development as well.
- Folate, also known as folic acid and vitamin B9, is an essential nutrient for preventing birth defects. In particular, adequate folate helps to prevent neural tube defects, those affecting the spinal cord and brain. The role folate takes in preventing these defects is most critical during the first trimester of pregnancy.
- Protein is essential for the development of the fetus, and just over two pounds of protein will be taken in by the baby throughout pregnancy. Women should eat 25 grams of additional protein each day during the second and third trimesters of pregnancy.
- Iodine helps maintain normal thyroid function in expecting mothers. The thyroid is important for body temperature control, metabolism, heart rate, and hormone regulation.
- Omega-3 fatty acids support development of the fetal brain and also decrease the risk of postpartum depression.

Pregnant women should avoid consuming large quantities of fish because of the risk of consuming heavy metals like mercury. Acceptable fish high in omega-3s include the following:

- Salmon
- Anchovies
- Herring
- Trout
- Sardines

Alternative sources of omega-3s include ground flaxseeds, walnuts, hemp seeds, seaweed, leafy green vegetables, algae, and canola oil. Pregnant women should limit the previously listed fish, despite their being rich in omega-3 fatty acids, to six ounces or less per week.

DID YOU KNOW

That there are many things pregnant women should completely avoid? Here's a list of some of the most important:

- Tobacco products
- Alcohol
- Hair dyes and chemicals
- Cured meats and deli meats
- Soft cheeses
- More than 300 milligrams of caffeine per day
- Artificial sweeteners
- Raw eggs
- Raw seafood

Some types of fish should never be consumed during pregnancy: swordfish, king mackerel, tilefish, and shark.

Breastfeeding

For new moms who choose to breastfeed, one concern they may have is whether restricting calories and exercising will impact their milk supply. Studies have found that exercise “had no adverse effect on the volume or composition of the breast milk, infant’s weight gain, or maternal prolactin levels.” Experts report, though, that nursing mothers should eat between 400 to 500 additional calories per day to support breast milk production. These additional calories should come from whole grains, protein, and lots of colorful fruits and vegetables. A nutrition coach can help a postpartum mother calculate her calorie needs while taking these factors into account.

Good hydration is important for everyone but especially for new mothers. Nursing mothers should drink at least one cup of water at each feeding to prevent dehydration.

Breast Milk Facts

Breast milk plays a very important nutritional role in the physical and mental development of a baby.

- Breast milk is a living substance. It has live cells—stem cells—that proliferate into other cell types such as the brain, heart, kidney, or bone tissue.
- Breast milk has antibodies and live white blood cells that protect the baby from infection. The amount of antibodies in breast milk increases if the mother or baby gets sick.
- Colostrum—the first milk produced after the birth of a baby—has special proteins that coat the inside of the baby’s intestinal tract to protect it from harmful bacteria.
- During breastfeeding, the mother’s brain releases the hormones prolactin and oxytocin to help mother and baby bond.
- Mothers who breastfeed have a lower risk of developing breast cancer, ovarian cancer, heart disease, stroke, type 2 diabetes, and postpartum depression.
- Breastfeeding lowers the risk of the baby developing common childhood illness such as ear infections, respiratory infections, and gastroenteritis.

MENOPAUSE

Menopause is part of the natural aging process for females. Around age 50, the ovaries stop producing estrogens. The body still produces estrogen from fat cells and the adrenal glands, but when the ovaries cease production, blood levels of estrogens drop dramatically.

MENOPAUSE:

The period in a woman’s life (typically after the age of 50) when the ovaries cease the production of estrogen and progesterone and menstruation ends.

Signs and Symptoms

Some women may not have any symptoms while others experience the full range, including the following:

- Hot flashes / body temperature regulation issues
- Depression
- Irritability
- Anxiety
- Changes in body composition and fat distribution
- Changes in sleep efficiency or patterns

Nutrition

Diet—specifically animal protein intake—may play a role in when menopause hits as well as the severity of symptoms (hot flashes). Research suggests that the intake of animal products has such a sufficiently great effect on hormones that it can affect the functioning of the body.

For women experiencing hot flashes, a low-fat, vegetarian diet is strongly recommended.

Regular physical activity—a brisk walk every day—also seems to alleviate hot flashes.

Table 18.4 Dietary Recommendations in Menopause

GENERAL DIETARY RECOMMENDATIONS IN MENOPAUSE	
Calcium	Two to four servings of calcium-rich foods per day
Vitamin D	Between ages 51–70, get at least 600 IU per day; over 70, get 800 IU daily
Iron	At least three servings of iron-rich foods per day
Fiber	Twenty-one grams per day
Fruits and vegetables	At least 1.5 cups of fruit and two cups of vegetables daily
Water	Drink eight glasses of water daily
Fat	Fat should comprise no more than 25 to 35 percent (or less) of total daily calories; saturated fat should comprise 7 percent or less
Sugar and salt	Reduce sugar and salt intake
Alcohol	Limit alcohol

ANDROPAUSE

While women experience a sudden drop in hormone production with the onset of menopause, **andropause**, sometimes called male menopause, happens gradually. Andropause may also be called testosterone deficiency syndrome, androgen deficiency of the aging male, or late-onset male hypogonadism. Testosterone levels vary among men. However, hormone levels decrease with age, so older men have less testosterone than younger men. The average decline is about 1 percent per year after age 30.

ANDROPAUSE:

Referred to as male menopause, it is a syndrome associated with low levels of testosterone in older and aging men.

Signs and Symptoms

Men going through andropause may experience any of the following:

- Reduced sexual desire (libido)
- Erectile dysfunction
- Fewer spontaneous erections
- Infertility
- Insomnia or increased sleepiness
- Increased bodyfat
- Reduced muscle mass and strength
- Decreased bone density
- Loss of body hair
- Decreased motivation
- Depression
- Trouble concentrating or with memory

Nutrients

One common cause for andropause is zinc deficiency. Zinc is involved in almost every aspect of male reproduction. Taking 30 to 45 milligrams of zinc per day with 2 to 3 milligrams of copper has been shown to help.

OLD AGE

As age-related or lifestyle-related decline progresses, barriers to good nutrition increase and present a special challenge to the certified nutritionist.

As people age, they become less active, their metabolism slows, and their energy and nutrient needs decrease. Although they should eat less, many continue to consume similar amounts of food as they used to when they were younger and more active.

Here are a few factors affecting dietary intake in aging people:

- Loss of appetite
- Changes in taste
- Reduced ability to smell
- Reduced ability to swallow

These factors can influence people in making poorer food choices and choosing overly sweet or salty processed foods manufactured to feel, look, smell, and taste good in the mouth.

Older adults can also experience decreased mobility as they age. Grocery shopping, opening cans or jars, and cooking become more difficult and may push them to choose faster, easier, and often less healthy options—fast food, microwave meals, and so on. A fixed income after retirement may also make it difficult for older adults to choose high-quality foods, as they can be more expensive.



Nutrients

Working within the individual constraints of each client, it is important for a nutrition coach to advocate including the following nutrients.

Table 18.5 Nutrients and Foods for the Elderly

NUTRIENT	FOOD CHOICES	BENEFITS
Calcium and vitamin D	Fortified cereals and fruit juices Dark-green leafy vegetables Canned fish with soft bones Milk and fortified plant beverages	Supports bone health
Vitamin B12	Fortified cereals Lean meats Some fish and seafood	Supports bone health Prevents anemia May reduce risk of macular degeneration Promotes brain health Increases energy Supports heart health
Fiber	Whole-grain breads and cereals Beans and peas Fresh fruits and vegetables	Promotes regularity Lowers risk of heart disease Prevents type 2 diabetes
Potassium	Fruits and vegetables Beans	Lowers the risk of hypertension

FOOD ALLERGY:

An abnormal immune response (such as vomiting, hives, or trouble breathing) to a food.

FOOD INTOLERANCE:

Digestive issues or distress after consuming a food or ingredient.

ELIMINATION DIET:

A physician- or dietitian-prescribed eating plan in which a client will gradually remove foods from their diet with the goal of determining what is causing an allergy or intolerance.

FOOD ALLERGIES AND HYPERSENSITIVITIES

There is a difference between a food allergy and a food intolerance. A **food allergy** occurs when the body's immune system responds to a food as if it is harmful and tries to destroy it.

A **food intolerance** means the body has a difficult time digesting a food or ingredient in the food—such as dyes, preservatives, or other added chemicals. In general, food intolerances or allergies are considered hypersensitivities.

SIGNS AND SYMPTOMS

With a food allergy, symptoms include rash, hives, trouble breathing, swelling, cough, and watery eyes. With food intolerance, symptoms may include stomach trouble (gas, pain, or bloating), diarrhea, headache, fatigue, or acid reflux.

DID YOU KNOW

That one of the most severe and fatal food allergies in the United States is shellfish allergy? Shellfish include shrimp, lobster, and crab, and even the simple act of preparing these items can cause a reaction to those affected.

If a client is concerned they might have a food hypersensitivity, they need to consult their physician. The physician can then perform allergy testing or prescribe an **elimination diet** - typically monitored by a registered dietitian—to determine which foods may be triggering symptoms.

Common Food Hypersensitivities

Depending on the individual, anything can be the cause of a food allergy or intolerance. There are many triggers not referenced here, so a coach should refer a concerned client to their primary care physician or a registered dietitian for insight into any symptoms they may have.

1 **Gluten**

Gluten is a type of protein found in wheat, barley, and rye. It is common in many processed foods as a binding agent. Clients can avoid gluten by eating fruits, vegetables, meat and poultry, fish and seafood, dairy, beans, legumes, and nuts. Alternative grain and starch options include amaranth, arrowroot, cassava, chia, corn, flax, gluten-free oats, millet, nut flours, potato, quinoa, rice, sorghum, soy, tapioca, and yucca.

2 **Soy**

One of the most common allergies in children is soy, although many tend to grow out of it. Soy, however, is one of the eight major allergens. Federal law requires food manufacturers to list potential soy ingredients or contamination on any food sold in the United States.

Soy can be found in baked goods, canned broths and soups, canned tuna and meat, cereals, cookies, crackers, high-protein energy bars and snacks, infant formulas, low-fat peanut butter, pet food, processed meats, sauces, soaps, and moisturizers.

3 **Lactose**

Nearly 65 percent of the world's population has trouble digesting lactose.

Lactose is a natural sugar found in milk, cheese, and other dairy products.

4 **Shellfish**

Certain proteins found in marine creatures trigger reactivity in the human body.

Clams, crabs, lobster, oysters, scallops, and shrimp are included in this food group.

5 **FODMAP**

FODMAP is an acronym for fermentable oligosaccharides, disaccharides, monosaccharides, and polyols. This is a group of carbohydrates that draws water into the intestine during digestion. Many individuals—around 86 percent—with irritable bowel syndrome react to high-FODMAP foods.

Table 18.6 FODMAP Ratings of Common Foods

HIGH FODMAP				LOW FODMAP	
<ul style="list-style-type: none"> • agave • almond meal • amaranth flour • apples • apricots • artichoke • asparagus • avocado • baked beans • bananas • barley • beer • black-eyed peas • blackberries • bran cereals • butter beans • buttermilk • cashews • cauliflower • celery • cheese 	<ul style="list-style-type: none"> • cherries • chorizo • coconut water • couscous • cream • currants • custard • dates • figs • fructose • fruit and herbal teas with added apple • garlic • gelato • gnocchi • granola • grapefruit • high-fructose corn syrup • honey • hummus 	<ul style="list-style-type: none"> • ice cream • kefir • kidney beans • kombucha • lima beans • lychee • mango • milk • molasses • muesli cereal • mushrooms • nectarines • onions • peaches • pears • persimmon • pesto • pistachios • plums • pomegranate • prunes • raisins • rum 	<ul style="list-style-type: none"> • rye • sausages • scallions • shallots • sour cream • soybeans • soy milk • spelt flour • split peas • sports drinks • stock cubes • watermelon • wheat-containing products • whey protein • wine • yogurt 	<ul style="list-style-type: none"> • alfalfa • bean sprouts • black beans • bok choy • broccoli • brussels sprouts • butternut squash • cabbage • carrots • chick peas • chives • collard greens • corn • cucumber • eggplant • fennel • ginger • green beans • green pepper • kale • lettuce 	<ul style="list-style-type: none"> • okra • olives • potato • pumpkin • radish • red peppers • seaweed • spinach • squash • sweet potato • tomato • turnip • zucchini

6 **Caffeine**

Caffeine is a stimulant found in coffee, soft drinks, tea, and energy drinks. It reduces fatigue and increases alertness by blocking receptors for adenosine (a sleep-wake-cycle regulating hormone). For people with caffeine hypersensitivity, it may cause rapid heartbeat, anxiety, jitters, insomnia, nervousness, or restlessness.

7 **Nuts**

Nuts are one of the most common food allergies in the United States, affecting adults and children alike. Typically caused by tree nuts and peanuts, symptoms can range from hives to nausea and become as severe as anaphylaxis. Products with nuts (or ones produced and handled in facilities that house nuts) are often very clearly marked.

DID YOU KNOW

That anaphylactic shock is a potentially life-threatening allergic reaction to a food or ingredient? The onset is characterized by a sudden drop in blood pressure and the narrowing or blocking of airways.

Epinephrine, often provided in the form of an EpiPen or something similar, is used to treat anaphylactic shock. Epinephrine causes the blood vessels to quickly constrict, raising blood pressure as well as relaxing the muscles of the airway and opening the lungs.

Individuals with known allergies will often carry epinephrine with them, and most restaurants and eateries have them for emergencies as well

OTHER SPECIAL SCENARIOS

Other special nutrition scenarios a nutrition coach may encounter include clients who are injured or recovering from an injury (and cleared by a medical practitioner), bodybuilders, people with general inflammation, and athletes.

INJURY

Injury can occur in many ways and may or may not include the presence or loss of blood. Cuts, bruises, fractures, sprains, muscle trauma, dislocations, and swelling are just a few potential injuries. Acute injuries occur suddenly, chronic injuries build and exist over time, and overuse injuries are caused by repetition or movement dysfunctions.



Healing takes time and requires a three-step process in the body. The first phase is known as hemostasis. This is when blood forms at the sight of the injury and clumps together to form a clot in the case of bleeding. The clot protects the wound and stops further blood loss. The clot—made of platelets and a fiber called fibrin—turns into a scab as it dries.

The next phase is inflammation. Once the wound has been closed, the body sends a fresh supply of nutrient- and oxygen-rich blood to the site to support growth and regeneration. Chemical signals tell the cells to create collagen, which serves as a type of scaffolding for the regeneration of new tissue.

During remodeling, the third phase, the body reinforces tissues around the wound area. Within the first six weeks, the wound heals quickly. At about three months post-injury, the wound area is about 80 percent as strong as it was prior to the trauma.

In cases of large, severe wounds, the healing process can take up to a couple of years to complete.

Inflammation

The inflammation phase is worth discussing in depth as the term has taken on a negative connotation in recent years.

As just discussed, one of the natural responses to injury is inflammation. Yet many people take drastic measures to reduce inflammation during the acute stage of wound repair. Suppressing this response is not necessary, although controlling it can be beneficial.

Nutrition plays a key role in managing inflammation. As a result of inflammation in the body, free radicals are produced, and these free radicals cause damage to cells. Flavonoids—

FREE RADICALS:

Cleaved atoms that can damage proteins, DNA, and cell membranes by stealing their electrons in a process called oxidation.

antioxidants found in cocoa, tea, red wine, fruits, vegetables, and legumes—help manage inflammation. Eating foods rich in flavonoids is advisable for general health and even more beneficial in acute stages of injury.

Other antioxidants—vitamins C, E, and A, beta-carotene, selenium, and zinc—neutralize **free radicals** and help repair the cellular damage they caused. Garlic, turmeric, green tea, blueberries, apples, citrus fruits, and pineapples all contain valuable antioxidants.

Injuries Involving Immobilization

If an injury is severe enough to warrant immobilization of an extremity, extra care must be taken. Immobilization of a limb may result in atrophy.

Energy

Under energy restriction (or immobilization), increasing energy intake in the form of consumed calories can lead to an increase of total and fat mass. However, research has shown that an injury may increase basal metabolic rate by up to 50 percent after a major surgery.

An individual who typically intakes 2,000 kcal with no exercise may need to intake as many as 2,400 kcal after minor surgery. As a general rule, energy requirements after an injury are less than they were during hard training but more than during inactivity.



Protein and Amino Acids

During healing, protein intake should be maintained or increased (about 2–2.5 grams per kilogram of bodyweight per day). Research suggests that evenly distributing protein intake throughout the day is most beneficial for optimal healing. Consuming 20 to 30 grams per meal or snack is recommended.

Table 18.7 A List of Foods with 20 to 30 Grams of Protein

FOOD AND QUANTITY
3 eggs
1 cup cottage cheese
1 cup Greek yogurt
3–4 ounces of meat, poultry, or fish
2/3 of a 14-ounce cake of firm tofu
1.25 cups of black beans

Some studies show that branched chain amino acids (BCAAs) (whether consumed through foods or in supplemental forms) may boost protein synthesis and prevent protein breakdown. Leucine has been found to have the greatest effect on protein synthesis. Foods rich in leucine include the following:

- Chicken breast
- Turkey breast
- Lean beef
- Eggs
- Tuna
- Peanuts
- Salmon

Other Nutrients and Healing

Scientific evidence suggests that omega-3 fatty acids may help prevent muscle loss and that creatine may enhance muscle hypertrophy (growth) during healing.

In general, a well-balanced eating pattern will support quick healing in most people. The variety and consistency of a good diet will provide all the required vitamins and minerals for cell growth and repair.

Nutrition Support for Concussion and Brain Injuries

Loss of normal energy production, oxidative stress, and long-term brain inflammation occur after a concussion or traumatic brain injury. Recent research findings have given insight into how specific chemicals in the diet can target these negative effects. Initial studies on animals have found that supplementing with vitamins B3, D, and E improved cognitive function following repetitive concussive brain injury. It is possible that these vitamins may also alleviate some of the long-term consequences of traumatic brain injury.

Magnesium and zinc have also been seen as beneficial in brain trauma research. Supplementing zinc for four weeks following a traumatic brain injury reduced inflammation and neuronal cell death and decreased depressive symptoms in rats. Finally, omega-3 fatty acids—specifically DHA and alpha-linolenic acid—seemed to offer neuroprotective qualities whether taken before or after injury.

BODYBUILDING

Resistance training increases lean muscle mass by causing micro-damage to skeletal muscle, which is then repaired and strengthened with new, denser muscle tissue. Individual adaptations to resistance training depend on the training program and intensity as well as the athlete's gender and nutritional status. To increase muscle gains via nutrition, many individuals use one or more of the following methods:

- Protein supplementation
- Protein/nutrient timing
- Bulking phase (calorie surplus)
- Carbohydrate loading



Protein Supplementation

One of the most common methods individuals use to accelerate lean muscle gains is to increase protein intake through supplementation (in addition to consumed protein from meats, legumes, and nuts). Skeletal muscle is made mostly of water and protein, with other materials making up just about 5 percent of the tissue. Therefore, it seems logical that increasing protein intake would increase muscle hypertrophy.

Studies show that resistance training alone boosts muscle mass and strength better than protein supplementation. However, for those who do not consume enough protein daily, supplementation has been shown to have a positive effect on muscle growth.

Protein Timing

Many experienced athletes and gym-goers commit to timing their meals around training sessions. However, the science doesn't support this. The major benefit to timing protein intake is to spread it out over the course of a day to promote more efficient absorption, as the body can absorb only 35 to 50 grams at a time.

Some personal trainers suggest that clients consume protein at intervals less than or equal to one hour before or after the workout. The goal is to give the body the right energy substrates to repair muscles after resistance training-related damage. Although these studies reported positive adaptations to muscle strength and hypertrophy, there was no “ideal window of opportunity” that increased outcomes. The positive effects were from increased protein intake, not timing.

Bulking Phase

The bulking phase of training is often mistaken for the overconsumption of calories without increasing activity level or intensity during exercise. If done correctly, there is a delicate balance between calories and increased resistance or intensity in a training session to prevent an increase in bodyfat mass in addition to muscle mass. Muscle hypertrophy requires a surplus of calories, but the type of calories consumed matters. Most athletes and clients will focus on the addition of complex carbohydrates and protein as an energy source, as they are used most readily in muscle repair post-exercise.

Carbohydrate Loading

The practice of carbohydrate loading is typically used by physique competitors and endurance athletes prior to competition. Typically, carbohydrate consumption is dramatically increased over the course of 24 to 48 hours pre-competition so that the body stores the excess glycogen in the muscle tissue and liver to be used as a quick-access energy source.

Carbohydrates bind to water in the body. For every gram of carbohydrate (glycogen), there are 2.7 to 4 grams of water stored with it. In the case of carb loading, when excess glycogen is stored in muscle cells, then water is also stored. This has the effect of increasing the fullness of the muscle. In physique competition, this ratio must be closely monitored so that excess glycogen does not “spill over” to the subcutaneous tissue. When this happens, the muscles look less hard, which is detrimental in aesthetics competitions. Endurance athletes are more concerned with loading as much carbohydrate into their bodies as possible to store glycogen for the event ahead, often following a strict regimen of carbohydrate depletion followed by carbohydrate supercompensation.

For some, carbohydrate loading can cause gastrointestinal distress and, most visibly, bloating, edema, and water retention.

WEIGHT LOSS

There are many trending diets able to aid in weight loss. Generally, a weight-loss nutritional program aims to reduce overall calories consumed daily. The nutrition guidelines chapter of this text takes a deeper dive into the general healthy-eating guidelines, which promote a healthy, sustainable weight and prevent chronic disease.

Supplementation

Reducing waist circumference is important, as abdominal fat has been linked to increased risk of chronic disease and premature death. However, care must be taken when suggesting supplements to clients for weight loss. Over-the-counter herbs, stimulants, and appetite suppressants are mostly ineffective and may have additives or additional ingredients and stimulants that can be considered dangerous. A nutrition coach must fully understand a client’s allergies and health history prior to making any supplement suggestions.

Healthy Weight Loss

According to Nutrition.gov, the US Department of Agriculture's website, a healthy weight-loss program should include

- a reasonable, realistic weight-loss goal;
- a reduced-calorie, nutritionally balanced eating plan;
- regular physical activity; and
- a behavior change plan to support new, healthy habits.

ATHLETES

When it comes to athletes, a coach must consider how nutrition will support performance and recovery.

Performance

During exercise training and competition, an athlete must have enough carbohydrates and protein to replenish glycogen stores and to build and repair muscle tissue. Fat intake should be moderate but not reduced, as the body needs essential fatty acids (which are not produced in the body), and fat plays an important role in many body processes and in hormone production.

Proper hydration should be the focus before, during, and after activity for all athletes. Sports beverages with carbohydrates and electrolytes may also help maintain blood glucose concentration, give fuel for working muscles, and decrease the risk of dehydration or **hyponatremia**.

With a balanced eating pattern focused on a variety of foods, nutritional supplementation is not necessary for most athletes.



HYPONATREMIA:

A condition in which the sodium levels in the blood are too low and internal water regulation becomes problematic.

Recovery

If athletes do not have adequate rest from training, or if they do not have a healthful eating pattern, they can increase their risk of injury. Carbohydrate intake before and during long bouts of exercise helps keep blood glucose levels stable, reduces stress hormones, and mitigates the risk of injury. Intakes of up to 60 grams per hour during heavy training can help reduce natural inflammatory responses.

Eating carbs after a long exercise bout replenishes glycogen stores, readying the muscles for the next session. Intake should be around 1 to 1.2 grams per kilogram of bodyweight from whole-food sources like fruits, starchy vegetables, whole grains, and whole-grain, fortified foods such as bread, cereal, rice, and pasta.

Generally, athletes should include 5 to 12 grams of carbohydrates per kilogram of bodyweight. Several studies have shown that combining protein and carbohydrates during and after exercise may

- decrease fatigue,
- reduce delayed onset muscle soreness, reduce muscle breakdown, and
- optimize muscle damage repair.

The suggested ratio for post-workout food consumption is three to four grams of carbohydrates for every gram of protein.



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The ISSA Nutrition course bridges the gap between science and application by giving students a deeper look into the mental aspects of making lasting behavior changes. The detail provided on digestion, human metabolism, and energy balance allow an ISSA nutrition coach to better understand what food does in the body. Only then can they better explain why a client's eating patterns are detrimental and help them understand what they must do to improve their state of health.

The ISSA Nutrition course teaches you how clients make food selections and what motivates their behaviors. You will be fully prepared to address healthy eating patterns, field questions about fad or trending diets and supplementation, and empower clients to have the autonomy and confidence to make beneficial nutrition decisions that effectively fuel their bodies.

ABOUT ISSA

The ISSA believes that the health and fitness of our society can be significantly improved by the success of our certified personal professionals. Our efforts to stem the tide of poor health and physical decline multiplies exponentially as our certified professionals disseminate the ISSA principles and methods to their clients, peers and associates. Our mission is to inspire our certified personal trainers to positively impact the quality of life of each individual with whom they come in contact.

ISSA is unconditionally committed to providing quality certification programs for competent practice in the health, sports and fitness specialty, advancing the fitness industry as a whole, and developing greater access to career opportunities for those who share our vision of creating a stronger, healthier world.

The ISSA is the world leader in fitness education and delivers comprehensive, cognitive and practical distance education for fitness professionals, grounded in industry research, using both traditional and innovative modalities. Founded in 1988 by Dr. Sal Arria and Dr. Frederick Hatfield, the ISSA now offers 12 fitness certifications and has certified over 300,000 trainers in 143 countries.

